FINAL UNDERGROUND STORAGE TANK QUALITY ASSURANCE PROJECT PLAN ADDENDUM FOR BUILDING 1279 CNC CHARLESTON SC

9/28/2012

RESOLUTION CONSULTANTS

Final UST QAPP Addendum
Building 1279, SCDHEC UST Permit # 15368
CHARLESTON NAVAL COMPLEX, SOUTH CAROLINA

Revision: 0
Prepared for:

Department of the Navy
Naval Facilities Engineering Command, Southeast
BRAC Program Management Office, SE
4130 Faber Place Drive
North Charleston, South Carolina 29405

Comprehensive Long-Term Environmental Action Navy
Contract Number N62470-11-D-8013

CTO # JM29

Prepared by:

Resolution Consultants
A Joint Venture of AECOM & EnSafe
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Virginia Beach, Virginia 23452

Submitted to:

South Carolina Department of Health and Environmental Control (SCDHEC)
Underground Storage Tank Management Division
2600 Bull Street,
Columbia, South Carolina 29201

September 2012

Section A: Project Management

A1: Title and Approval Page

Final
Quality Assurance Project Plan
Addendum to the SCDHEC UST Programmatic QAPP
Long-Term Groundwater Monitoring at Building 1279
Charleston Naval Complex,
Charleston, South Carolina
Revision 0

Prepared for: Department of the Navy
Naval Facilities Engineering Command, Southeast
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4130 Faber Place Drive
North Charleston, South Carolina 29405

Prepared by: Resolution Consultants
A Joint Venture of AECOM & EnSafe
3820 Faber Place Drive, Suite 300
Charleston, SC 29405

Date: September 2012

AECOM Technical Services, Inc.
Contractor Certification No. UCC 0035
SCDHEC UST Permit # 15368

Approvals

Ms. Susan B. Fulmer SCDHEC Project Manager	____________ Signature	____________ Date
Art Sanford BRAC PMO SE	____________ Signature	09/21/2012 Date
Doria Cullom Resolution Consultants QA Manager	Doria R. Cullom Signature	09/21/2012 Date
Shawn E. Dolan Resolution Consultants Task Manager	Shawn E Dolan Signature	09/21/2012 Date
Scott Bailey GCAL Laboratory Director	____________ Signature	09/21/2012 Date

A2: Table of Contents

Figures

Tables

Appendices

List of Acronyms

BRAC PMO	Base Realignment and Closure Program Management Office
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CA	Corrective Action
CLEAN	Comprehensive Long-Term Environmental Action Navy program
CNC	Charleston Naval Complex
COC	Chain of Custody
CTO	Contract Task Order
DO	Dissolved Oxygen
DOC	Demonstration of Capability
DoD	Department of Defense
DQI	Data Quality Indicator
DQO	Data Quality Objectives
ELAP	Environmental Laboratory Approval Program
EPA	Environmental Protection Agency
GCAL	Gulf Coast Analytical Laboratories, Inc
GC/MS	Gas Chromatograph/Mass Spectrometer
HASP	Health and Safety Plan
IR	Infrared
JV	Joint Venture
MDL	Method Detection Limit
MNA	Monitored Natural Attenuation
NA	Not Applicable
NAVFACSOUTHEAST	Naval Facilities Engineering Command, Southeast
NELAC	National Environmental Laboratory Accreditation Conference
ORP	Oxidation-Reduction Potential
PID	Photoionization Detector
PM	Project Manager
ppm	Parts per Million
QA	Quality Assurance
QC	Quality Control
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
RBSL	Risk Based Screening Level
RPD	Relative Percent Difference
SCDHEC	South Carolina Department of Health and Environmental Control
SOP	Standard Operating Procedure
UST	Underground Storage Tank

A3: Distribution List

In accordance with the South Carolina Department of Health and Environmental Control's (SCDHEC) *Quality Assurance Program for the Underground Storage Tank Management Division* (SCDHEC, June 2011), hence referred to in this document as the Master Underground Storage Tank (UST) Quality Assurance Project Plan (QAPP), the personnel listed in this site-specific QAPP addendum will be receiving a copy of both the Master UST QAPP and this site-specific addendum. The Master UST QAPP is provided in Appendix A of this document. Personnel listed in the distribution list (Table 1A) will be required to acknowledge that they have received a copy of the most recent Master UST QAPP and the site-specific QAPP Addendum. For the purposes of this project, the acknowledgement for the receipt of this document will consist of either an email or similar electronic correspondence to the Resolution Consultants Project Manager, Mr. Shawn Dolan, at shawn.dolan@aecom.com. The acknowledgements will be stored in the electronic project file at Resolution Consultants. The Master UST QAPP and this site-specific addendum, and subsequent revisions thereof, will be distributed to the following:

Name	Title	Organization/Address	Telephone #	Fax #	Email
Ms. Susan B. Fulmer	SCDHEC Technical Project Manager	SCDHEC - UST Management Division/ 2600 Bull Street, Columbia, SC 29201	(803) 896.6676	803.896.6245	fulmersb@dhec.sc.gov
Mr. Art Sanford	BRAC PMO SE Restoration Program Manager	BRAC PMO SE 4130 Faber Place Drive, Suite 202 North Charleston, SC 29405	(843) 743.2135	843.743.2142	art.sanford.ctr@navy.mil
Mr. David Criswell	BRAC PMO SE Deputy Base Closure Manager	BRAC PMO SE 4130 Faber Place Drive, Suite 202 North Charleston, SC 29405	(843) 743-2130	843.743.2142	david.criswell@navy.mil
Ms. Doria Cullom	Quality Assurance Manager	Resolution Consultants/ 10 Patewood Dr., Suite 500, Greenville, SC 29615	(864) 234.3000	864.234.3069	doria.cullom@aecom.com
Mr. Shawn E. Dolan	Project Manager	Resolution Consultants/ 3820 Faber Place, Suite 300, Charleston, SC 29405	(843) 740.7356	843.740.0975	shawn.dolan@aecom.com
Codee Buckler	Field Manager	Resolution Consultants/ 3820 Faber Place, Suite 300, Charleston, SC 29405	(843) 740.7316	843.740.0975	codee.buckler@aecom.com
Ms. Karen S. Varnado	Quality Assurance Manager	Gulf Coast Analytical Laboratories, Inc. (GCAL) 7979 GSRI Rd. Baton Rouge, LA 70820	(228) 214.4108	225.767.5717	KarenV@gcal.com
Mr. Scott Bailey	Laboratory Manager	GCAL 7979 GSRI Rd. Baton Rouge, LA 70820	(225) 214.2041	225.767.5717	ScottB@gcal.com

Table 1A Addendum Distribution List

A4: Project Organization

At the request of the Naval Facilities Engineering Command, Southeast (NAVFACSOUTHEAST) and the Base Realignment and Closure Program Management Office (BRAC PMO), Resolution Consultants has prepared the following UST QAPP Addendum for the Building 1279 site (UST Permit Number 15368) at the former Charleston Naval Complex (CNC), Charleston, SC. Resolution Consultants, a Joint Venture (JV) between AECOM Technical Services, Inc. and Ensafe Inc., is performing this work under Contract Task Order (CTO) JM29 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) program. Resolution Consultants' JV partner AECOM Technical Services Inc., UCC #0035, is the site rehabilitation contractor for this project. The key individuals for this project are listed below in Table 2A. An organizational chart for this project is presented as Figure 1A. The roles and responsibilities of the individuals are defined below.

SCDHEC Technical Project Manager

- Provides direct oversight of site rehabilitation contractor
- Reviews project plans and reports
- Reviews and approves recommendations for future work
- Reviews and approves site-specific QAPPs

BRAC PMO SE Restoration Program Manager

- Serves as the point of contact between the installation and SCDHEC
- Provides direct oversight of site rehabilitation contractor
- Reviews project plans and reports
- Reviews and approves recommendations for future work
- Reviews and approves site-specific QAPPs

Site Rehabilitation Contractor

- Manages and coordinates field and office activities needed for assessments or cleanup
- Performs activities involving data analysis and interpretation
- Must be registered with SCDHEC as a Class One Site Rehabilitation Contractor
- Site rehabilitation contractors that perform activities involving only data collection (e.g., drilling, sampling) must be registered with SCDHEC as a Class Two Site Rehabilitation Contractor
- Validates and verifies the Project Data

Analytical Laboratory

- Receives the groundwater samples from the site rehabilitation contractor
- Performs the requested analyses, and provides analytical reports
- Must be certified by the SCDHEC Office of Laboratory Certification in accordance with Regulation R.61-81 for the analytical methods performed

Project Manager

- Serves as primary contact for the client
- Coordinates the overall project
- Ensures overall project performance
- Establishes schedule projections
- Reports to the BRAC PMO SE Restoration Program Manager on the progress of individual tasks
- Implements Quality Control (QC) project directives from the Quality Assurance (QA) Task Manager
- Reviews field operating procedures and QC procedures
- Directs development of project work plans, QC procedures, QAPPs, and project Site Safety and Health Plans
- Provides senior technical and QC oversight of project operations

Field Operations Manager

- Reports to the Project Manager on progress of field work and QC results
- Directs daily project operations and QC procedures
- Ensures that field staff follow the project work plan, QAPP, and Site Safety and Health Plan
- Assures representative samples and measurements are collected according to the project's QC procedures
- Documents operations, problems, and operational changes associated with field work

QA Task Manager

- Directs field QA audits and Reviews field QA audit reports, if necessary
- Develops project-specific QAPPs
- Maintains the official, approved QAPP
- Advises and directs the Project Manager and principal-in-charge on QA/QC procedures and project compliance
- Reviews subcontract laboratory qualifications and resolves project operations and laboratory QC conflicts

Role	Individual	Organization	Telephone #	Fax #	Email
SCDHEC UST Program Project Manager	Susan B. Fulmer	SCDHEC - UST Management Division	803.896.6676	803.896.6245	fulmersb@dhec.sc.gov
BRAC PMO SE Restoration Program Manager	Mr. Art Sanford	BRAC PMO SE	843. 743.2135	843.743.2142	art.sanford.ctr@navy.mil
Site Rehabilitation Contractor	Shawn E. Dolan	Resolution Consultants - Charleston	843.740.7356	843.740.0975	shawn.dolan@aecom.com
Field Manager	Codee Buckler	Resolution Consultants - Charleston	(843) 740.7316	843.740.0975	codee.buckler@aecom.com
Quality Assurance Manager/Validator	Ms. Doria Cullom	Resolution Consultants - Greenville	864.234.3000	864.234.3069	doria.cullom@aecom.com
Analytical Laboratory Director	Mr. Scott Bailey	GCAL	225.214.7041	225.767.5717	ScottB@gcal.com
Project Verifier	Mark Darrington	Resolution Consultants - Charleston	843.740.7332	843.740.0975	mark.darrington@aecom.com

Table 2A Addendum Role Identification and Contact Information

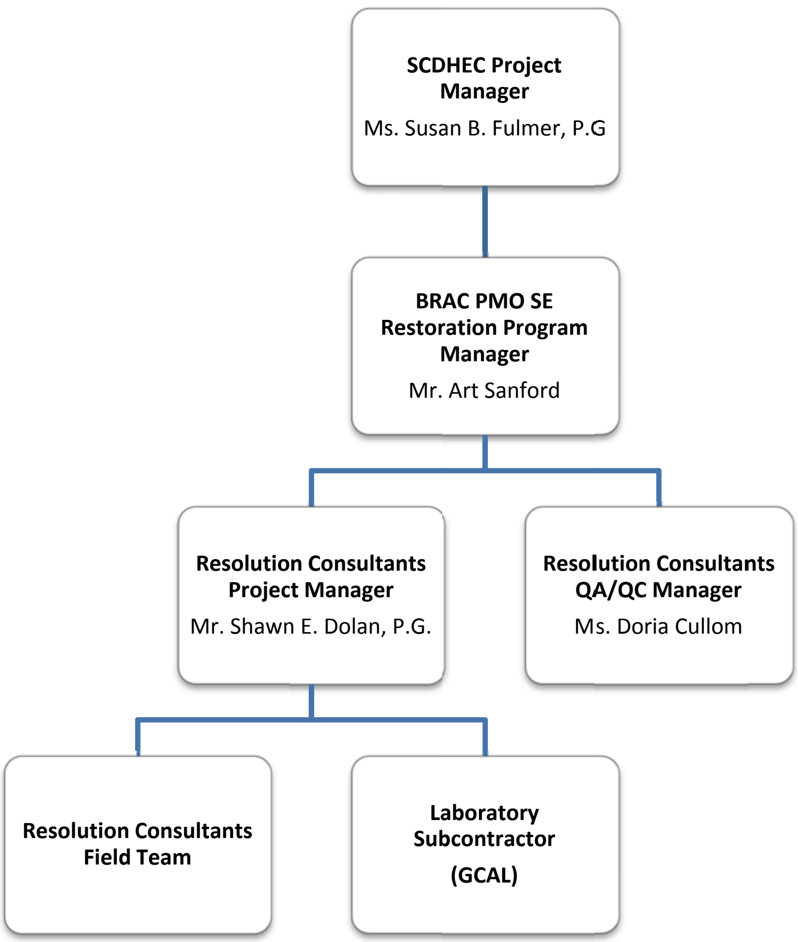

Figure 1A Organizational Chart

A5: Problem Definition/Background

Building 1279 (AOC 734) is located on the former CNC in Charleston, SC. The site is regulated under SCDHEC UST Permit # 15368. A site map is provided as Figure 2A. The former Building 1279 area is a fenced storage facility, previously utilized by CNC for the storage of materials. Currently, the former Building 1279 area is owned by the City of North Charleston and leased to the Noel Brothers Company, who uses it for bulk storage. The area of former Building 1279 is bordered to the north by Building 30, to the east by North Hobson Street and Detyens Shipyards, Inc., to the south by Pipefitter Street, and to the west by Kephart Street (Figure 2A). Groundwater monitoring wells 1279MW001, 1279MW002, and 1279MW003 were installed at Building 1279 by ADVENT in November 2004 as part of a UST investigation. The wells were developed and initially sampled in November 2004 as part of a Tier-I investigation under the SCDHEC UST Division. Analytical results from the Tier-I investigation detected naphthalene in the sample collected from 1279MW002 and benzene in the sample collected from 1279MW003 above SCDHEC's Risk Based Screening Levels (RBSLs). The sample collected from 1279MW001 did not contain any groundwater contaminant concentration above laboratory detection limits.

A sampling history was provided by Tetra Tech in LTM letter to Ms. Susan Fulmer (SCDHEC) dated July 9, 2012. Based on the information provided in the letter, periodic groundwater sample collection has been conducted at Building 1279 as part of an ongoing Monitored Natural Attenuation (MNA) Program since November 2005. During the November 2005 sampling event, concentrations of benzene and naphthalene were detected in the sample collected from 1279MW003 at concentrations exceeding the RBSLs. During the August 2008 sampling event, benzene was detected in the sample collected from 1279MW002 at a concentration exceeding its RBSL. During the February 2009 sampling event, benzene, ethylbenzene, naphthalene, and xylenes were detected in the sample collected from 1279MW003, but at concentrations below the RBSLs. During the August 2009 sampling event, naphthalene was detected in each of the samples collected from the three wells and benzene and ethylbenzene were detected in the sample collected from 1279MW003; however, each of the detected concentrations were below the RBSLs. During the February 2010 sampling event, benzene and ethylbenzene were detected in the sample collected from 1279MW003, with only benzene being reported at a concentration exceeding its RBSL. Two MNA groundwater sampling events were conducted at Building 1279 in August 2011 and February 2012. Samples were collected from 1279MW003 for analysis of BTEX and naphthalene. Benzene and naphthalene were detected in the sample collected from 1279MW003 in both August 2011 and February 2012; however, the detection of naphthalene during the February 2012 sampling event was reported at a concentration exceeding its RBSL.

A6: Project/Task Description

This project is regulated under the Underground Storage Tank Division of SCDHEC. Resolution Consultants will conduct groundwater sampling at monitoring well 1279MW003 for Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and naphthalene and will measure water levels in all 3 monitoring wells (1279MW001, 1279MW002, and 1279MW003) to verify groundwater flow direction. BTEX and naphthalene samples will be analyzed using Environmental Protection Agency (EPA) Method 8260B (or most current).

Field measurements will be collected during sampling activities to include the amount of water purged, pH, temperature, conductivity, dissolved oxygen (DO), oxidation-reduction potential (ORP), turbidity, depth to water, and purge rate. All field data and sampling activities will be documented on appropriate forms.

Groundwater sampling activities and results will be documented in an Annual Groundwater Monitoring Report. The report will include sample collection field sheets, chain of custody forms, laboratory analytical result tables, a table of sample results above detection limits, and a table of field duplicate results. A figure indicating well locations and the results of the annual sampling event will also be included. The report will also address the activities and findings of groundwater monitoring activities and address recommendations for future sampling. The recommendations will include an optimization evaluation to address monitoring frequencies, plus analyte and well reduction or addition, as appropriate, based on the sampling data.

The field activities will begin within 30 working days after approval of this QAPP Addendum, pending the scheduling availability of the drilling company. Sampling should be completed within 5 days after initiation of the field work.

A7: Data Quality Objectives (DQOs) and Data Quality Indicators (DQIs)

In accordance with Section A7 of the Master UST QAPP (Appendix A), Section A7 of this QAPP Addendum consists of Step 4 (Defining the Study Boundary) of the DQO process. To meet this requirement, Building 1279 is presented in Figure 2A. The site map also contains the location of the monitoring well that will be sampled for this project. The remaining DQO's and DQI's for this project are presented in the Master UST QAPP in Appendix A.

A8: Training and Certificates

Title	Name	Training Required	Date of Training	License	License Number
Project Manager (PM)/Geologist	Shawn E. Dolan	OSHA Hazwoper and 8- Hour Refresher	January 5, 2012	Professional Geologist	2373
Project Scientist	James (Lorenzo) Jackson	OSHA Hazwoper and 8- Hour Refresher	January 5, 2012	NA	NA
Staff Scientist	Megan Bell	OSHA Hazwoper and 8- Hour Refresher	January 5, 2012	NA	NA
Staff Scientist	Codee Buckler	OSHA Hazwoper	October 8, 2011	NA	NA
Staff Scientist	Sarah Rollins	OSHA Hazwoper	July 22, 2012	NA	NA

Note: NA – Not Applicable

Table 3A Required Training and Licenses

Shawn Dolan of Resolution Consultants is responsible for ensuring that personnel participating in this project have the proper training. All training records will be stored electronically in Resolution Consultants's project files at the following location: Resolution Consultants, 3820 Faber Place Drive, Suite 300, Charleston, SC 29405.

It is understood that training records will be produced if requested by SCDHEC.

The following Laboratory will be used for this Project:

Gulf Coast Analytical Laboratories, Inc. (GCAL)

Lab Manager: Scott Bailey

SCDHEC Certification Number: 73006001

Parameters this Lab will analyze for this project: BTEX and Naphthalene (EPA method 8260B).

Please note: SCDHEC may require that the contractor submit some or all of the Laboratory's Standard Operating Procedures (SOPs) as part of this QAPP. Referenced laboratory SOPs for this document are provided in Appendix B.

A9: Documents and Records

Personnel will receive the most current version of the QAPP Addendum via:

(Check all that apply)

____US Mail   X Courier   Hand delivered

Record	Produced By	Hardcopy/ Electronic	Storage Location for How Long?	Archival
Field notes/Field Forms/logbook	Resolution Consultants	Electronic	Resolution Consultants, Charleston, SC - 5 Yrs minimum	Charleston Naval Complex
Chain of custody forms	Resolution Consultants/GCAL	Electronic	Resolution Consultants, Charleston, SC - 5 Yrs minimum	Charleston Naval Complex
Laboratory raw data package	GCAL	Electronic	Resolution Consultants, Charleston, SC/GCAL - 5 Yrs minimum	Charleston Naval Complex
Audit/assessment checklists/reports	Resolution Consultants/GCAL	Electronic	Resolution Consultants, Charleston, SC/GCAL - 5 Yrs minimum	Charleston Naval Complex
Plans/Reports	Resolution Consultants/GCAL	Electronic	Resolution Consultants, Charleston, SC - 5 Yrs minimum	Charleston Naval Complex
Correspondence	Resolution Consultants/SCDHEC	Electronic	Resolution Consultants, Charleston, SC - 5 Yrs minimum	Charleston Naval Complex
Validated data	Resolution Consultants	Electronic	Resolution Consultants, Charleston, SC - 5 Yrs minimum	Charleston Naval Complex

Table 4A Record Identification, Storage, and Disposal

Section B: Measurement/Data Acquisition

B1: Sampling Process/Experimental Design

Item	Start Date	End Date	Comments
Groundwater Sampling	September 2012 (estimated)	September 2012 (estimated)	Within 30 business days of SCDHEC Notice to Proceed

Table 5A Sampling Activities

B2: Sampling Methods

Figure 2A depicts the monitoring well location for the groundwater samples. Please note: The contractor must follow sampling protocols as given in the UST Master QAPP (Appendix A).

Estimate the number of samples of each matrix that are expected to be collected:

Soil ___0___

Ground Water from monitoring wells ___1___

From Drinking/Irrigation water wells ___0___

From surface water features ___0___

Total number of Water samples ___1___

Note – In addition to the samples listed above, Quality Control samples will consist of trip blanks (1), field blanks (1), and duplicate samples (1). Quality Control sampling requirements are provided in Section B5.

The samples will be (check as many as apply): ____Homogenized ____Split

For the sample matrices indicated above, please describe how samples will be collected and the equipment needed.

Prior to collecting groundwater samples, depth to groundwater will be measured to the nearest 0.01 foot using an oil/water interface probe or equivalent at each well location. Low-flow purging and sampling of the monitoring wells will be performed using a peristaltic pump with Teflon®-lined polyethylene tubing. New Teflon®-lined polyethylene tubing will be used at each well to eliminate the potential for cross-contamination. If a monitoring well is purged dry, the sample will be collected when the well has recharged to a sufficient volume.

A reading of the breathing zone air at the well head will be collected using a photoionization detector (PID) for additional safety. The health and safety plan (HASP) will provide detailed action levels for the field staff to take the proper precautions.

Will Sampling Equipment have to be cleaned and decontaminated or is everything disposable?

Disposable Teflon®-lined polyethylene tubing will be used; new tubing will be used at each well to eliminate the potential for cross-contamination. Sampling equipment will not require decontamination.

If sampling equipment must be cleaned please give a detailed description of how this is done and the disposal of by-products from the cleaning and decontamination.

- Not applicable

Identify any equipment and support facilities needed. This may include such things as Federal Express to ship the samples, and electricity to run sampling equipment.

- Federal Express
- Vehicle to load equipment and run electricity for pump
- PID
- Peristaltic Pump
- YSI 556 Water Quality Meter
- HF Scientific, Micro TPW Turbidity Meter

- Oil/Water Interface Probe

Address the actions to be taken when problems occur in the field, and the person responsible for taking corrective action and how the corrective action will be documented.

Failure	Response	Documentation	Individual Responsible
Field Equipment	Unit will be replaced as necessary and inform Resolution Consultants PM	Daily Field Log	Resolution Consultants Field Team Leader
Safety Issues	Proceed in accordance with HASP and inform Resolution Consultants PM.	Daily Field Log	Resolution Consultants Field Team Leader
Access Issues	Resolution Consultants PM will be informed and assistance of Navy Point of Contact will be solicited to resolve any access issues.	Daily Field Log	Resolution Consultants Field Team Leader
Wells Not Located	Use detector and measure from known points, contact project manager.	Daily Field Log	Resolution Consultants Field Team Leader
Sampling Procedure	Consult appropriate SOP for corrective action and inform Resolution Consultants Project Manager. Resample if necessary.	Daily Field Log	Resolution Consultants Field Team Leader

Table 6A Field Corrective Action

B3: Sample Handling and Custody

1. How will the samples get from the Site to the Lab to ensure holding requirements are met?

Federal Express will be used to ship sample via overnight air to the laboratory.

2. How will the contractors cool the samples and keep the samples cool?

Samples will be placed in an iced cooler and shipped on wet ice.

3. How will the lab determine the temperature of the samples upon receipt? Will they be using a temperature blank?

An Infrared (IR) thermometer will be used to determine the temperature of the samples. Temperature blanks are included as requested in the bottle kit request.

4. Where will the samples be stored in the Lab once they are received?

GCAL has six coolers for sample storage. Samples aliquots are stored based on the test requested. All aliquots are given a unique number and bar code. Sample coolers include volatile solids, two coolers for volatile waters, semi-volatile waters and semi-volatile and metal solid samples, general chemistry waters, and hazardous waste. GCAL also has two hold coolers if any discrepancy is noted at login, one for volatiles and one for all additional testing. Sample extracts are held in dedicated freezers.

5. Describe the chain of custody procedure and attach a copy of each chain of custody that will be used. If a Chain of Custody SOP exists from the Lab and the Contractor is willing to adhere to it, then this may be attached.

Copies of GCAL's Chain of Custody Forms and/or Field Sheets are maintained with project records. Legal Chain of Custody includes the sample custody information. Legal Chain of Custody begins when field personnel receive sample containers. The Section Supervisor (i.e. Field Supervisor, Laboratory Supervisor) is responsible for ensuring that the chain of custody protocol is maintained. All entries shall be made in waterproof ink. Errors are rectified with a line through them. Supervisors ensure that all documentation is signed, initialed and dated by the responsible party. All documentation/logs are signed/initialed by appropriate personnel.

The Chain of Custody (COC) is signed at sample receipt and the air bill tracking number(s) is kept with the COC. Sample transfers for receipt, analysis, and disposal is recorded in GCAL's LIMS using the aliquot bar code. Information recorded includes each analyst taking custody, the date, time, sample location, and reason code. See GCAL SAD-002.

B4: Analytical Methods

1. Identify the SOPs which will be used to analyze the samples, the method which the SOP references and the equipment or instrumentation that is needed:

Parameter	SOP ID*	Method Referenced	Equipment	Comments
Volatiles (BTEX, Naphthalene)	GCMSV-003 Revision 23	SW8260B	Gas Chromatograph/Mass Spectrometer (GC/MS)	SOPs in Appendix B

Table 7A Analytical SOPs and Referenced Methods

• This can be a full name of a SOP, an abbreviation, or a number. In the latter two cases, the abbreviation or number must be associated with the full name of the SOP. See also Table 8A SOP Abbreviation Key.

Abbreviation	Lab Identification of this SOP	Full Name of this SOP
SW-846 8260B	GCMSV-003 Revision 23	SOP for GC/MS Volatile Organics (SW-846 8260B)

Table 8A SOP Abbreviation Key

2. Identify procedures to follow when failures occur, identify the individual responsible for corrective action and appropriate documentation:

SOPs, provided in Appendix B, contains the corrective action procedures for the analytical laboratory.

Failure	Response	Documented Where?	Individual Responsible
ICAL	Rerun, do not proceed with sample analysis	Data files	Analyst
ICV	Rerun, do not proceed with sample analysis	Data files	Analyst
CCV	Re-analyze CCV and all associated samples.	Data files	Analyst
Method Blank/CCB	Determine source of contamination, reanalyze all affected samples.	Data files, LIMS, Case Narrative	Analyst, Supervisor
LCS	Determine source of failure, re-analyze affected samples. High bias with no detects is reported with a case narrative.	Data files, LIMS, Case Narrative	Analyst, Supervisor
MS	Determine if failure is due to sample matrix or laboratory error. Reprep/analyze if lab error is determined. Include in case narrative	Data files, LIMS, Case Narrative	Analyst, Supervisor
MSD, LCSD, Dup	Determine if failure is due to sample matrix or laboratory error. Reprep/analyze if lab error is determined. Include in case narrative	Data files, LIMS, Case Narrative	Analyst, Supervisor
Surrogates	Determine if failure is due to sample matrix or laboratory error. Reprep/analyze if lab error is determined. Include in case narrative	Data files, LIMS, Case Narrative	Analyst, Supervisor

Table 9A Corrective Action Procedures

3. Identify sample disposal procedures.

Analysis	Matrix	Schedule for Disposal	Method for Disposal	Comments
8260B	Water	60 Days	Acid Waste Drum	Veolia

Table 10A Sample Disposal

4. Provide SOPs for the Kerr Method or the Ferrous Iron Method if these are parameters for this study. This can be attached or written here. If attached please note that it is an attachment and where it is located (if applicable).

Neither the Kerr nor the Ferrous Iron Methods are part of this investigation.

B5: Quality Control Requirements:

All QC will follow the requirements laid out in Section B5 of the UST Programmatic QAPP (Appendix A). At a minimum, the QC samples collected for this investigation will include the following:

Trip Blanks – To be submitted with each sample cooler.

Field Blanks – One field blank to assess the potential contamination from the site environment for each site.

Field Duplicates – One field duplicate will be collected for every twenty samples submitted to the laboratory for testing.

Trip Blanks will be analyzed for volatile constituents BTEX and Naphthalene (EPA method 8260B). All other QC samples will be analyzed for BTEX and Naphthalene.

B6: Field Instrument and Equipment Testing, Inspection and Maintenance

All equipment will be routinely inspected and maintained according to the service and instruction manuals. Maintenance documentation for the equipment will be kept on file and made available to SCDHEC upon request. All instruments and equipment will be tested, inspected, and maintained according to the manufacturer's guidelines and recommendations. Project staff that have been properly trained in these procedures will operate the instruments.

Instrument	Serial #	Type of Maintenance	Frequency	Parts Needed/ Location	Person Responsible
PID	Varies	Preventative Repairs	As needed	Rental Vendor	Rental Vendor
YSI 556	Varies	Preventive Maintenance	As needed	Rental Vendor	Rental Vendor
HF Scientific , Micro TPW	Varies	Preventive Maintenance	As needed	Rental Vendor	Rental Vendor
Gas Chromatograph Mass Spectrometer (GCMS)	Varies See GCAL QAPP (Appendix B)	Preventive Maintenance	As needed	Agilent	GCAL Personnel

Table 11A Instrument and Equipment Maintenance

Instrument/ Equipment & Serial #	Type of Inspection	Requirement	Individual Responsible	Resolution of Deficiencies
Agilent GC/MS	Tune	SOP/Method	Analyst	Clean sample introduction, clip or replace column, clean source

Table 12A Instrument and Equipment Inspection

B7: Instrument Calibration and Frequency

All field equipment needed for sampling, as well as safety equipment, will be calibrated prior to and during continued use to assure that all measurements are as accurate as possible. Personnel will follow the manufacturer's instructions to determine if the instruments are functioning within their established operation ranges. The calibration will be recorded in the field logbook as well as the field data sheet. The field analyst will specify the identification of the field instrument by serial number in the field logbook as well as the field data sheet so that the calibrations are traceable to a specific piece of equipment. A PID (MiniRae 2000 or MiniRae 3000) will be used in the field as a safety precaution for Resolution Consultants staff. The instrument will be calibrated with 100 parts per million (ppm) isobutylene and fresh air in accordance with the manufacturers' specifications. The YSI 556 Water Quality Meter (or equivalent) equipped with a flow-through cell will be used to measure pH, specific conductivity, turbidity, DO, ORP, and temperature. The instrument will be calibrated with manufacturer provided calibration solutions for each field parameter. HF Scientific, Micro TPW Turbidity Meter will be used to measure turbidity.

To be acceptable, a field test must be bracketed between acceptable calibration results.

1. The first check may be an initial calibration, but the second check must be a continuing verification check.

2. Each field instrument must be calibrated prior to use.

3. Verify the calibration at the beginning of each work shift, during use, and at the end of the use.

4. All initial calibration and verification checks must meet the acceptance criteria in the table below.

5. If an initial calibration or verification check fails to meet the acceptance criteria, immediately recalibrate the instrument or remove it from service.

6. If a verification check fails to meet the acceptance criteria and it is not possible to reanalyze the samples, the following actions must be taken:

a. Report all results between the last acceptable verification check and the failed check as 'estimated' (qualified with a "J");

b. Include a narrative of the problem; and

c. Shorten the time period or frequency between verification checks or repair/replace the instrument.

7. All acceptable field data must be bracketed by acceptable checks or the data must be qualified.

Any sampling equipment or field measurement instrument determined to be malfunctioning in any way must be repaired and recalibrated or removed from service. This corrective action must be documented in the records.

Laboratory equipment calibration protocols are addressed within SOPs that are reviewed by the SCDHEC's Office of Environmental Laboratory Certification. Laboratory equipment will have a calibration log book for each piece of instrument that will be maintained by the analyst.

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference*
PID – MiniRae 2000 or MiniRae 3000	In accordance with instrument manual	Beginning and end of each day. Any time during the day if a verification check fails.	< ± 5% of true value	Replace Unit	Field Team Leader/PM	In accordance with instrument manual
YSI 556	In accordance with instrument manual	Beginning and end of each day. Any time during the day if a verification check fails.	Varies per parameter. Conducted in accordance with instrument manual	Replace Unit	Field Team Leader/PM	In accordance with instrument manual
HF Scientific , Micro TPW	In accordance with instrument manual	Beginning and end of each day. Any time during the day if a verification check fails.	In accordance with instrument manual	Replace Unit	Field Team Leader/PM	In accordance with instrument manual
GC/MS	In accordance with GCAL QAPP and Referenced SOPs				GCAL Analyst	GCMSV-003 Revision 23

Table 13A Instrument Calibration Criteria and Corrective Action

B8: Inspection/Acceptance Requirements for Supplies and Consumables

In accordance with the Master UST QAPP (Appendix A) Table 14A below provides a list of items for field sampling. The analyzing laboratory will provide documentation of the integrity of the sample containers. Supplies and consumables for field and laboratory analysis are inspected as part of Resolution Consultantss and GCALs standard operating procedures. Resolution Consultants shall maintain documentation of the acceptability of all analytical consumables used in the field.

Item	Vendor	Acceptance Criteria	Handling/Storage Conditions	Person Responsible for Inspection and Tracking
Nitrile Gloves	Varies	No holes; must be nitrile (not latex)	1 box of each appropriate size per vehicle	Resolution Consultants Staff
Sample containers	Laboratory	Sealed and unbroken, certified as pre-cleaned	Stored in zip loc bags inside cooler pending sampling	Resolution Consultants Staff
Sample Coolers	Laboratory	Used only for sample transportation, in good condition, no damage that would compromise sample integrity	Resolution Consultants warehouse pending use in field	Resolution Consultants staff
Silicon Tubing	Varies	Disposable, received in sealed plastic bags directly from vendor.	Resolution Consultants warehouse pending use in field	Resolution Consultants staff
Teflon-lined Tubing	Varies	Disposable, received in sealed plastic bags directly from vendor.	Resolution Consultants warehouse pending use in field	Resolution Consultants staff

Table 14A List of Consumables and Acceptance Criteria

B9: Data Acquisition Requirements (Non-Direct Measurements)

Data Source	Used For	Justification for Use in this Project	Comments
Historical Reports	Previous site investigations, contaminants, and well construction/location information.	Required to obtain historical site information	

Table 15A Non-Direct Measurements

B10: Data Management

Data reduction, review, validation, and reporting procedures are provided below. These procedures are established to (1) minimize data transcription and reduction errors, (2) ensure that all data are reviewed and the review is documented, (3) provide ready access to data records, and (4) ensure that reported results are qualified appropriately. Laboratory data reduction, review, and verification procedures are required to ensure the overall objectives of analysis and reporting meet the DQOs.

Screening Data

Resolution Consultants shall review all (100 percent) of the screening data provided on the field records. Calibration and corrective action requirements are provided in Section B7.

Definitive Data

Definitive data analytical methods and procedures are provided in Section B4. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or not performed.

Laboratory

The laboratory analyst performing the tests shall review 100 percent of the definitive data. The data shall be reviewed against the criteria specified in this QAPP, the criteria detailed in the laboratory-specific SOPs, National Functional Guidelines (as applicable), and the specific SW-846 methods. After the analyst's review has been completed, the laboratory supervisor of the respective analytical section shall review, independently, 100 percent of the data using the same criteria. The supervisor or designee generates the case narrative per batch of samples and approves the batch in the LIMS. The supervisor or designee generates the report and reviews the report for completeness, consistency, correct deliverables and flagging. The Data Validation Department generates the report package and performs a third level of review to ensure the report is complete and is consistent with SOP and project requirements. The Data Validation Department signs all final reports.

The laboratory QA section shall review 10 percent of the completed data packages.

Resolution Consultants

Resolution Consultants shall review 100% of the definitive data report packages. All data in the definitive data report packages shall be reported as Level III (to include the case narrative, chains-of-custody, cooler temperatures, condition upon receipt forms, holding times, analytical data, surrogate recoveries, laboratory control sample recoveries/laboratory control sample duplicate Relative Percent Differences (RPDs), method blanks, matrix spike recoveries, and matrix spike duplicate RPDs. The data shall be reviewed against the criteria specified in this QAPP, the criteria detailed in the laboratory-specific SOPs, National Functional Guidelines (as applicable), and the specific SW-846 methods and, based on this review, apply appropriate final data qualifiers for the definitive data.

Record Management

The laboratory shall maintain electronic and hardcopy records sufficient to recreate each analytical event conducted pursuant to this investigation. The minimum records the laboratory shall keep contain the following: (1) COC forms; (2) initial and continuing calibration records, including standards preparation traceable to the original material and lot number; (3) instrument tuning records (as applicable); (3) method blank results; (4) internal standard results; (5) surrogate spiking records and results (as applicable); (6) spike and spike duplicate records and results, (7) laboratory records; (8) raw data, including instrument printouts, bench work sheets, and/or chromatograms with compound identification and quantitation reports; (9) corrective action reports; (10) other method and project required QC samples and results; and (11) laboratory-specific written SOPs for each analytical method and QA/QC function in place at the time of analysis of project samples. The records shall be maintained for a minimum period of ten years. More detailed information regarding record management is provided in Section 5.7 of the laboratory's Quality Manual (Appendix B).

Section C: Assessment and Oversight

C1: Assessment and Response Actions

1. The Contractor is supposed to observe field personnel daily during sampling activities to ensure samples are collected and handled properly and report problems to SCDHEC within 24 hours. Please state who is responsible for doing this and what observations will be made. Will this person have the authority to stop work if severe problems are seen?

Resolution Consultants's Project Manager, Mr. Shawn Dolan, is responsible for reviewing daily field activities and ensuring that samples are collected and handled properly. Mr. Dolan will review sample collection, field screening, and sample custody activities and will have the authority to stop work and initiate corrective action, if necessary.

2. The SCDHEC UST QAPP states that the Lab will receive an Offsite Technical System Audit. For this project, what assessments will be done on the Commercial Lab(s) that are being used—other than their certification audit? When or how often are these done? Who will the results be given to and who has the ability to stop work if problems are severe?

GCAL is audited by clients, Department of Defense (DoD) Environmental Laboratory Approval Program (ELAP) and the National Environmental Laboratory Accreditation Conference (NELAC). DoD and NELAC audits are conducted a minimum of every two years. Client audits do not have a schedule, but typically occur at the beginning of certain projects with some that perform periodic audits. The results of these audits are provided to the lab. Client audits are made available to the lab and appropriate staff within the client's organization. The Lab Director and Quality Assurance Officer (QAO) have the ability to stop work if problems are severe. Desk audits of laboratory SOPs, method detection limits (MDLs), and demonstration of capability (DOC) are performed by SCDHEC annually.

C2: Reports to Management

See the SCDHEC UST Programmatic QAPP (UST Master QAPP).

Section D: Data Validation and Usability

See the SCDHEC UST Programmatic QAPP (UST Master QAPP).

Figure 2A

Legend

- Monitoring Wells
- Building 1279

0 50 100 150 200 Feet

FIGURE 2A
Site Features
Building 1279
Charleston Naval Complex
Charleston, South Carolina

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: SED	DATE: September 2012
DRAWN BY: SCR	TASK ORDER NUMBER: JM 29

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Appendix A

UST Master QAPP

QUALITY ASSURANCE PROGRAM PLAN
FOR THE UNDERGROUND STORAGE TANK MANAGEMENT DIVISION

Bureau of Land and Waste Management
South Carolina Department of Health and Environmental Control
Columbia, South Carolina

June 2011

Document Review and Revision Record

Note: Actions older than 5 years may be removed from this record

Approval Date	Revision No.	Record of Activity
06/14/2011	1	Text revisions, well numbering, field laboratory certification removed

Section A – Project Management

A1 Quality Assurance Program Plan Identification Form

Document Title: Quality Assurance Program Plan
Underground Storage Tank (UST) Management Division
Bureau of Land and Waste Management (BLWM)
South Carolina Department of Health and Environmental Control (SCDHEC)

Address: 2600 Bull Street
Columbia, SC 29201

Telephone: (803) 896-6240

Plan Coverage: This Quality Assurance Plan covers all water and soil quality data collection as well as analysis activities conducted by or regulated by the UST Management Division at SCDHEC.

APPROVAL FOR AGENCIES

Christopher S. Doll, PG, UST QAPP Coordinator *Bureau of Land and Waste Management* *SCDHEC*	06-13-2011 *Date*
Daphne Neel, Chief *Bureau of Land and Waste Management* *SCDHEC*	6/14/11 *Date*
Danny France, Quality Assurance Manager *Office of QA and Data Integration* *USEPA, Region 4*	6/14/11 *Date*
Nydia Burdick, Quality Assurance Officer *Environmental Quality Control* *SCDHEC*	6-13-2011 *Date*

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List of Terms Used in This Document:

· Abatement - Actions taken to mitigate fire and safety hazards and to prevent further migration of hydrocarbons in their vapor, dissolved, or liquid phase.

· Accuracy - A measure of the closeness of an individual measurement or the average of a number of measurements to the true value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; the EPA recommends using the terms “precision” and “bias”, rather than “accuracy,” to convey the information usually associated with accuracy. Refer to Appendix E, Data Quality Indicators for a more detailed definition.

· Active Remediation - Physical actions taken to reduce the concentration of CoCs to acceptable levels.

· Assessment - The evaluation process used to measure the performance or effectiveness of a system and its elements. As used here, assessment is an all-inclusive term used to denote any of the following: audit, performance evaluation (PE), management systems review (MSR), peer review, inspection, or surveillance

· Attenuation - The reduction in concentration of CoCs in the environment with distance and time due to processes that include, but are not limited to, diffusion, dispersion, and absorption.

· Audit (quality) - A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.

· Bias – The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the sample measurement is different from the sample’s true value-in one direction- high or low).

· Blank – A sample subjected to the usual analytical or measurement process to establish a zero baseline or background value.

· Calibration – A comparison of a measurement standard, instrument, or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies and to report or eliminate those inaccuracies by adjustments.

· Certification – The process of testing and evaluation against specifications designed to document, verify, and recognize the competence of a person, organization, or other entity to perform a function or service, usually for a specified time.

· Chain of Custody – (COC) – An unbroken trail of accountability that ensures the physical security of the samples, data, and records.

· Chemical of Concern (CoC) - A specific constituent that is identified for evaluation in the risk assessment process.

· Compliance Point (CP) – see Point(s) of Compliance below.

· Compliance Point Concentration (CPC) - The maximum concentration allowable at the point of compliance in order to protect the exposure point.

· Corrective Action - any measures take to rectify conditions adverse to quality, and where possible, to preclude their recurrence. For instance in remaking standards in the case of a bad calibration.

· Corrective Action Plan (CAP) - A document outlining proposed site rehabilitation actions.

· Data Quality Assessment (DQA) - The scientific and statistical evaluation of data to determine if data obtained from environmental operations are of the right type, quality, and quantity to support their intended use. The five steps of the DQA Process include: 1) reviewing the DQOs and sampling design, 2) conducting a preliminary data review, 3) selecting the statistical test, 4) verifying the assumptions of the statistical test, and 5) drawing conclusions from the data.

· Data Quality Indicators (DQIs) - The quantitative statistics and qualitative descriptors that are used to interpret the degree of acceptability or utility of data to the user. The principal data quality indicators are bias, precision, accuracy (bias and precision are), comparability, completeness, and representativeness.

· Data Quality Objectives (DQOs) - The qualitative and quantitative statements derived from the DQO Process that clarify a study's technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

· Data Quality Objectives (DQO) Process - A systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use. DQOs are the qualitative and quantitative outputs from the DQO Process.

· Data usability – The process of ensuring or determining whether the quality of the data produced meets the intended use of the data.

· Department - The South Carolina Department of Health and Environmental Control.

· Detection Limit (DL) - A measure of the capability of an analytical method to distinguish samples that do not contain a specific analyte from samples that contain low concentrations of the analyte; the lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated level of probability. DLs are analyte- and matrix-specific and may be laboratory-dependent.

· Direct Exposure Pathway - An exposure pathway where the point of exposure is at the source without a release to any other medium (for example, inhalation of vapors or dermal contact with free product).

· Engineering Controls – Permanent or temporary manmade modifications to a site to reduce or eliminate the potential for exposure to a CoC, such as capping or installing a water treatment system on a well.

· Engineering Report (ER) - A document outlining the design and specifications of a site rehabilitation system.

· Exposure - Contact of a receptor(s) with CoC(s). Exposure is quantified as the amount of CoC available at the exchange boundaries, such as skin or lungs, and available for absorption by the human body.

· Exposure Assessment - The determination or estimation, qualitative or quantitative, of the magnitude, frequency, duration, and route of exposure.

· Exposure Pathway - The course CoCs travel from the source area(s) to a receptor. A complete exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (e.g., ground water) is included.

· Exposure Point - The point at which it is assumed that a receptor, either potential or actual, can come into contact, either now or in the future, with the CoC. Maximum contaminant levels or other existing water quality standards must be met at the exposure point.

· Exposure Route - The manner in which CoCs come in contact with an organism (i.e., ingestion, inhalation, dermal contact).

· Field blank — A blank used to provide information about contaminants that may be introduced during sample collection, storage, and transport. A clean sample, carried to the sampling site, exposed to sampling conditions, returned to the laboratory, and treated as an environmental sample.

· Flag — A notation to indicate that the data point associated must be qualified—that a deficiency or deviation exists that is associated with that sample. Flags often appear to resemble footnotes. The notation as to what the flag means is given further on in the document.

· Gas Chromatograph (GC) - An instrument used to determine the levels of CoCs in a vapor, soil or ground water sample.

· Holding time — The period of time a sample may be stored prior to its required analysis. While exceeding the holding time does not necessarily negate the veracity of analytical results, it causes the qualifying or "flagging" of any data not meeting all of the specified acceptance criteria. With regard to holding time, a day is defined as a period of 24 hours commencing at the time of sample collection and ending at the same time on the following calendar day.

· Initial Ground Water Assessment (IGWA) – An assessment to determine the presence of soil and ground water CoCs by the installation of one monitoring well.

· Indirect Exposure Pathways - An exposure pathway with at least one intermediate release to any media between the source and the point of exposure (e.g., leaching of CoCs from soil to ground water).

· Institutional Controls - The restriction on use or access (e.g., existing deed restrictions, restrictive zoning and conditions listed in the registry of releases) to a site or facility to eliminate or minimize potential exposure to CoCs.

· In-Situ Monitoring- Analysis or observations taken immediately at the site. For instance, pH analysis that must take place within 15 minutes of sample collection.

· Laboratory Fortified Blank (LFB) — A sample prepared by adding a known mass of a target analyte to a specified amount of analyte-free deionized (DI) water. Spiked samples are used, to determine the recoveries for samples taken through the procedure and are part of the quality control for the procedure.

· Laboratory Matrix spike (LFM) — A sample prepared by adding a known mass of a target analyte to a specified amount of a sample for which an independent estimate of the target analyte concentration is available. Spiked samples are used, for example, to determine the effect of the matrix on a method's recovery efficiency

· Limit of quantification — The minimum concentration of an analyte or Class of analytes in a specific matrix that can be identified and quantified above the method detection limit and within specified limits of precision and bias during routine analytical operating conditions.

· Maximum Contaminant Level (MCL) - A standard for drinking water established by the USEPA under the Safe Drinking Water Act. The MCL is the maximum permissible level of CoC in water that is used as a drinking water supply.

· Monitored Natural Attenuation (MNA) - The verifiable reduction of CoC through naturally occurring microbial activity or attenuation mechanisms.

·Must — When used in a sentence, a term denoting a requirement that has to be met.

· Operator – An entity as defined in Section 44-2-20(10) of the State Underground Petroleum Environmental Response Bank Act.

· Organic Vapor Analyzer (OVA) - A field instrument used to measure the organic vapors present in a sample of soil or ground water. A Photo Ionization Detector (PID) is a type of OVA.

· Owner – An entity as defined in Section 44-2-20(12) of the State Underground Petroleum Response Bank Act.

· Point(s) of Compliance - A location(s) selected between the source area and the exposure point(s) where CoCs must be at or below the determined target levels (CPC) in the specified media (e.g., soil, ground water, air).

· Point(s) of Verification - A location(s) selected for monitoring to verify a decrease in a CoC as a result of corrective action.

· Precision — A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions expressed generally in terms of the standard deviation. Refer to Appendix E, Data Quality Indicators, for a more detailed definition.

· Quality — The totality of features and characteristics of a product or service that bears on its ability to meet the stated or implied needs and expectations of the user.

· Quality Assurance (QA) — An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

· Quality Assurance Program Description/Plan — See quality management plan.

· Quality Assurance Project Plan (QAPP) — A formal document describing in comprehensive detail the necessary quality assurance (QA), quality control (QC), and other technical activities that must be implemented to ensure that the results of the work performed will satisfy the stated performance criteria. The QAPP components are divided into four classes: 1) Project Management, 2) Measurement/Data Acquisition, 3) Assessment/Oversight, and 4) Data Validation and Usability. Requirements for preparing QAPPs can be found in EPA QA/R-5.

· Quality Control (QC) — The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality. The system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring the results are of acceptable quality.

· Quality control (QC) sample — An uncontaminated sample matrix spiked with known amounts of analytes from a source independent of the calibration standards. Generally used to establish intra-laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system.

· Quality Management Plan (QMP) — A formal document that describes the quality system in terms of the organization's structure, the functional responsibilities of management and staff, the lines of authority, and the required interfaces for those planning, implementing, and assessing all activities conducted.

· Quality system — A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance (QA) and quality control (QC).

· Readiness review — A systematic, documented review of the readiness for the start-up or continued use of a facility, process, or activity. Readiness reviews are typically conducted before proceeding beyond project milestones and prior to initiation of a major phase of work.

· Reasonably Anticipated Future Use - Future land use that can be predicted given current use, local government planning, and zoning.

· Receptors - Persons, structures, utilities, surface water bodies, sensitive habitats, water supply wells, or any living organisms that are, or may be, affected by a release.

· Record (quality) — A document that furnishes objective evidence of the quality of items or activities and that has been verified and authenticated as technically complete and correct. Records may include photographs, drawings, magnetic tape, and other data recording media.

· Recovery — The act of determining whether or not the methodology measures all of the analyte contained in a sample. Refer to Appendix E, Data Quality Indicators, for a more detailed definition.

· Remediation — The process of reducing the concentration of a contaminant (or contaminants) in air, water, or soil media to a level that poses an acceptable risk to human health.

· Representative Concentration:

In Air - The maximum CoC concentration obtained during the most recent sampling event.
In Groundwater - The maximum CoC concentration obtained during the most recent sampling event.
In Soil - The maximum CoC concentration obtained during the most recent sampling event for the ingestion and dermal contact pathways. For the soil reaching groundwater pathway, the average of up to two soil samples with the highest non-zero concentrations from each source area will be used to compare with the screening levels.

·Repeatability - The degree of agreement between independent test results produced by the same analyst, using the same test method and equipment on random aliquots of the same sample within a short time period.

·Reporting limit - The lowest concentration or amount of the target analyte required to be reported from a data collection project. Reporting limits are generally greater than detection limits and are usually not associated with a probability level.

· Representativeness — A measure of the degree to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition. See also Appendix E, Data Quality Indicators.

·Reproducibility - The precision, usually expressed as variance that measures the variability among the results of measurements of the same sample at different laboratories.

· Risk Assessment - An analysis of the potential for adverse health effects caused by CoC to determine the need for site rehabilitation. Also used to develop target levels or cleanup goals if site rehabilitation is required.

· Risk Reduction - The lowering or elimination of the level of risk posed to human health or the environment through initial response actions, site rehabilitation, or institutional or engineering controls.

· Risk-Based Screening Level (RBSL) - Risk based action level for a CoC based on a 10^{-6} target risk. RBSLs are not site-specific.

· Separation Distance – The vertical distance between the depth of worst-case soil contamination and the depth to the top of the water table.

· Shall - A term denoting a requirement that is mandatory whenever the criterion for conformance with the specification permits no deviation. This term does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled.

· Site Assessment - The collection of data on ground-water quality and potential receptors, subsurface geology, hydrology, and site characteristics to determine the extent of the migration of the CoCs and action levels of the CoCs to support remedial action decisions.

· Site Classification - A qualitative risk evaluation of a site based on known or readily available information. Associated with site classifications are initial response actions that are to be implemented simultaneously with the RBCA process. Sites are re-classified as actions are taken to resolve concerns or as additional information becomes available.

· Site Rehabilitation - A subset of activities conducted to protect human health, safety, and the environment. These activities include recovery of free-product, evaluating risks, evaluating and implementing monitored natural attenuation, making no further action decisions, implementing institutional controls, active remediation, designing and operating cleanup systems and equipment, and monitoring of progress.

· Sensitive Habitat - Fresh and salt-water fisheries, fish habitats including shellfish areas, coastal and inland wetlands, and habitats of threatened or endangered species.

· Site-Specific Target Level (SSTL) - Risk-based corrective action target level for a CoC developed for a particular site under the Tier 2 and Tier 3 evaluations.

· Source Area - Either the location of free-phase hydrocarbons or the location of the highest concentration of the CoC in soil, vapor, or groundwater.

· Spike — A substance that is added to an environmental sample to increase the concentration of target analytes by known amounts; used to assess measurement accuracy (spike recovery). Spike duplicates are used to assess measurement precision.

· Standard Operating Procedure (SOP) - A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps and that is officially approved as the method for performing certain routine or repetitive tasks.

· Surrogate spike - A pure substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them to establish that the analytical method has been performed properly.

· Tier I Assessment – Previously known as a Standard Limited Assessment (SLA). A defined scope of work, consisting of three monitoring wells and eight soil borings, to determine soil and groundwater chemicals of concern, hydraulic properties and risk.

· Tier 1 Evaluation - A risk-based analysis where non-site-specific values based on conservative exposure factors (RBSL), potential exposure pathways, and land use are evaluated to determine appropriate actions. An Initial Ground-Water Assessment, Tier I Assessment, or Tier II Assessment may include a Tier 1 Evaluation for soil and ground water, if not previously completed.

· Tier II Assessment – Previously known as a Rapid Assessment (RA). A scope of work proposed by a certified site rehabilitation contractor, consisting of established tasks/components in order to provide a comprehensive risk-based assessment of soil and ground water chemicals of concern, hydraulic properties and risk.

· Tier 2 Evaluation - A risk-based analysis applying the RBSL at the exposure point, development of SSTLs for potential indirect exposure pathways based on site-specific conditions, and establishment of point(s) of compliance. A Tier I Assessment or Tier II Assessment may include a Tier 2 Evaluation for vapor, soil, and ground water, if not previously completed.

· Tier III Assessment – A scope of work proposed by a certified site rehabilitation contractor, consisting of established tasks/components in order to further refine the site specific target levels for potential and indirect exposure pathways established from a previously completed Tier II Assessment. A Tier III Assessment would typically incorporate a more sophisticated fate and transport model. Additional monitoring point(s) to further define the geological conditions or collect additional data may also be needed to refine other naturally occurring conditions at the facility or receptor(s). As the Department typically performs modeling, Tier III Assessments are not commonly performed.

· Tier 3 Evaluation - A risk-based analysis to develop values for potential direct and indirect exposure pathways at the exposure point based on site-specific conditions. A Tier II Assessment may include a Tier 3 Evaluation for vapor, soil, and ground water. The following table gives a comparison of the three tier evaluations:

Item		Tier 1 Evaluation	Tier 2 Evaluation	Tier 3 Evaluation
Screening Levels		RBSLs	RBSLs/SSTLs	RBSLs/SSTLs
Representative Concentrations –Air		Maximum CoC Concentrations	Maximum CoC Concentrations	Maximum CoC Concentrations
Representative Concentrations - Soil	Ingestions, Inhalation & Dermal Contact	Maximum CoC Concentrations	Maximum CoC Concentrations	Maximum CoC Concentrations
	Leachate	Maximum Concentration or average of samples	Maximum Concentration or average of samples	Maximum Concentration or average of samples
Representative Concentrations – Water		Maximum CoC Concentrations	Maximum CoC Concentrations	Maximum CoC Concentrations
Target Risk		1 x 10^{-6}	1 x 10^{-6}	1 x 10^{-6} or as approved
Hazard Quotient		1	1	1 or as approved
Exposure Factors		Not Applicable	Not Applicable	Default or Site-specific
Fate & Transport		Not Applicable	Domenico or equivalent	Numerical Models
Leachate		Not Applicable	Leachability Model	Leachability or other
Air		Not Applicable	Vapor Models	Vapor Models
Main Steps		Compare RBSLs, Site Conceptual Exposure Model, Receptors, Data requirements	Establish: Exposure Points, Points of Compliance and SSTLs	Further refine SSTLs based on additional data & modeling
Locations where RBSLs are applied		Source Area(s)	Exposure Point(s)	Exposure Point(s)
Data Collection		Source Area Characterization	Complete Plume Delineation	Detailed site-specific biodegradation study
Outcome of Evaluation		NFA, Tier 2 Evaluation, Emergency Action	NFA, CNFA, Corrective Action, Tier	CNFA, NFA, Corrective Action

		3 Evaluation	

Table 1 Comparison of the Tiers

- Trip blank - A clean sample of a matrix that is taken to the sampling site and transported to the laboratory for analysis without having been exposed to sampling procedures.

- Valid data – Data obtained from samples that were collected, preserved, handled, and analyzed according to the requirements of the UST Programmatic QAPP. To determine if data is valid, it will undergo and pass scrutiny via verification by the laboratory and contractor and validation by the UST Program.

- Validation — Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use have been fulfilled. In design and development, validation concerns the process of examining a product or result to determine conformance to user needs. See also Section D.

- Variance (statistical) — A measure or dispersion of a sample or population distribution.

- Verification — Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled. In design and development, verification concerns the process of examining a result of a given activity to determine conformance to the stated requirements for that activity. See also Section D.

Introduction

Environmental data are critical to decision-making concerning the protection of the public and the environment from the adverse effects of pollutants from leaking underground storage tanks. Environmental data are key to decisions and actions pertaining to environmental protection efforts in the air, land, and waters of the state. The success of environmental technology in abating pollution or remediation of sites depends upon proper design, construction and operation. Quality assurance (the documentation of quality control) and quality control practices are needed to ensure that data involving all environmental efforts - pollution abatement, cleanup, public health protection, and environmental technology - successfully perform their intended role.

Quality Assurance Policy

The UST Management Division of the SCDHEC Bureau of Land and Waste Management adopts by reference the following Quality Assurance Policy statement as documented in the Environmental Quality Control QMP.

It is the quality assurance policy of the Department that there will be sufficient QA activities conducted to demonstrate that all environmental data generated, processed, or used will be scientifically valid, legally defensible, and of known and acceptable precision and accuracy. It is also the Agency policy that documented precision and accuracy information is available upon request for all reported data. Data shall be complete, representative, and comparable. The quality of all data generated by and for SCDHEC shall meet or exceed all EQC and EPA program requirements.

A2 Authority

The South Carolina DHEC Underground Storage Tank Management Division Quality Assurance Project Plan is established under authority provided in Section II.A.1 of the SUPERB Site Rehabilitation and Fund Access Regulations, R.61-98.

A3 Distribution List

The South Carolina DHEC Underground Storage Tank Management Division Quality Assurance Project Plan, and subsequent revisions thereof, will be distributed to the following:

Name	Title	Organization/Address	Telephone Number	Fax Number	Email Address
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TBD –listed in the Addendums	Project Managers	SCDHEC, UST Management Division, 2600 Bull St., Columbia, SC, 29201	803-896-6241	803-896-6245	-----
SC Certified UST Site Rehabilitation Contractors*		This will be covered in the contractor's addendum to this Programmatic QAPP.			

Table 2 Distribution List

* Copies of the QAPP will be provided to all SCDHEC Certified UST Site Rehabilitation Contractors. It will be the responsibility of those contractors to provide the QAPP to any analytical laboratories or other subcontractors that they utilize.

The site-specific QAPP addendums will also have a distribution list of those personnel specific to the project that will be receiving a copy of the Master UST QAPP and the site-specific addendum. Personnel will be require to sign that they have received a copy of the most recent UST Programmatic QAPP and the site-specific QAPP Addendum.

A4 Organization

To implement this QA Program Plan, the UST Management Division has established a suitable management structure. Personnel from the Underground Storage Tank (UST) Management Division and Land and Waste Management of South Carolina Department of Health and Environmental Control (SCDHEC) will provide technical management and oversight of the site assessment work to be performed. Management and support personnel involved should be qualified, by training and/or expertise, to assume the necessary responsibilities. The successful implementation of the QA Program Plan involves a large educational component and cannot be accomplished in a brief time period.

Below are listed the responsibilities for key positions. The site-specific QAPP addendum will list roles with specific responsible parties as well as have its own organizational chart. The Addendum may also list additional roles depending on the scope of the project and the contractor.

The responsibilities of the participants are as follows:

1. EQC Quality Assurance Management Officer - The Manager of Office of Quality Assurance (QA) is responsible for the oversight of all quality assurance activities associated with SCDHEC sampling and analysis standard operating procedures (SOPs). The QA Manager reports directly to upper management. The QA Manager will resolve any issues when corrective actions are needed to address data quality issues involving SCDHEC staff and SOPs. The QA Manager will approve the

SCDHEC UST Programmatic QAPP. While the QA Manager will not review the addendums, the SCDHEC project officers will have guidance to ensure what is in the QAPP addendums is correct and complete.

2. **UST Management Division QAPP Manager -** The UST Management Division QAPP Manager is responsible for revisions to the UST Programmatic QAPP as necessary. The UST QAPP Manager will ensure that copies of the QAPP and all revisions are distributed to all parties listed in the Distribution List

3. **Division Directors -** The Division Directors will provide necessary liaison with the QA Manager and the Regional Office to help ensure that UST QA Program requirements are consistently met within the state.

4. **Section Managers -** Section Managers are responsible for oversight of the project managers. The Section Managers provide input to site-specific decisions in addition to ensuring consistency with policies and procedures of the UST Management Division. Section Managers will address QA matters with the Project Managers and the contractors at the site level and will approve site-specific QAPPs.

5. **Technical Project Managers -** Technical Project Managers are responsible for direct oversight of contractors conducting assessment and site rehabilitation of releases at UST sites. Project managers perform day-to-day review of plans and reports related to site rehabilitation activities on their assigned sites. These reviews include verification and analysis of data submitted to the UST Management Division by site rehabilitation contractors and analytical laboratories and recommendations for future work. Project Managers are responsible for the review of and approval of the site-specific QAPPs to ensure compliance with the UST Master QAPP. The Project Managers are also responsible for validating the Project Data.

6. **Site Rehabilitation Contractor -** The Site Rehabilitation Contractor is an independent contractor responsible for managing and coordinating field and office activities needed for assessments or cleanup. Site rehabilitation contractors that perform activities involving data analysis and interpretation must be registered with SCDHEC as a Class One Site Rehabilitation Contractor. Site rehabilitation contractors that perform activities involving only data collection (e.g., drilling, sampling) must be registered with SCDHEC as a Class Two Site Rehabilitation Contractor. The Contractor is also responsible for validating and verifying the Project Data.

7. **Analytical Laboratory -** The Analytical Laboratory receives the soil and water samples from the site rehabilitation contractor, performs the requested analyses, and provides analytical reports. Analytical laboratories must be certified by the SCDHEC Office of Laboratory Certification in accordance with Regulation R.61-81 for the analytical methods performed.
http://www.scdhec.gov/administration/regs/docs/61-81.pdf.

8. **Soil Boring and Monitoring Well Driller -** The Driller installs soil borings and monitoring wells for the Site Rehabilitation Contractor. All monitoring wells must be installed by a certified South Carolina well driller in accordance with South Carolina Well Standards R.61-71 (http://www.scdhec.gov/environment/water/regs/r61-71.pdf).

Organization Chart for SCDHEC UST

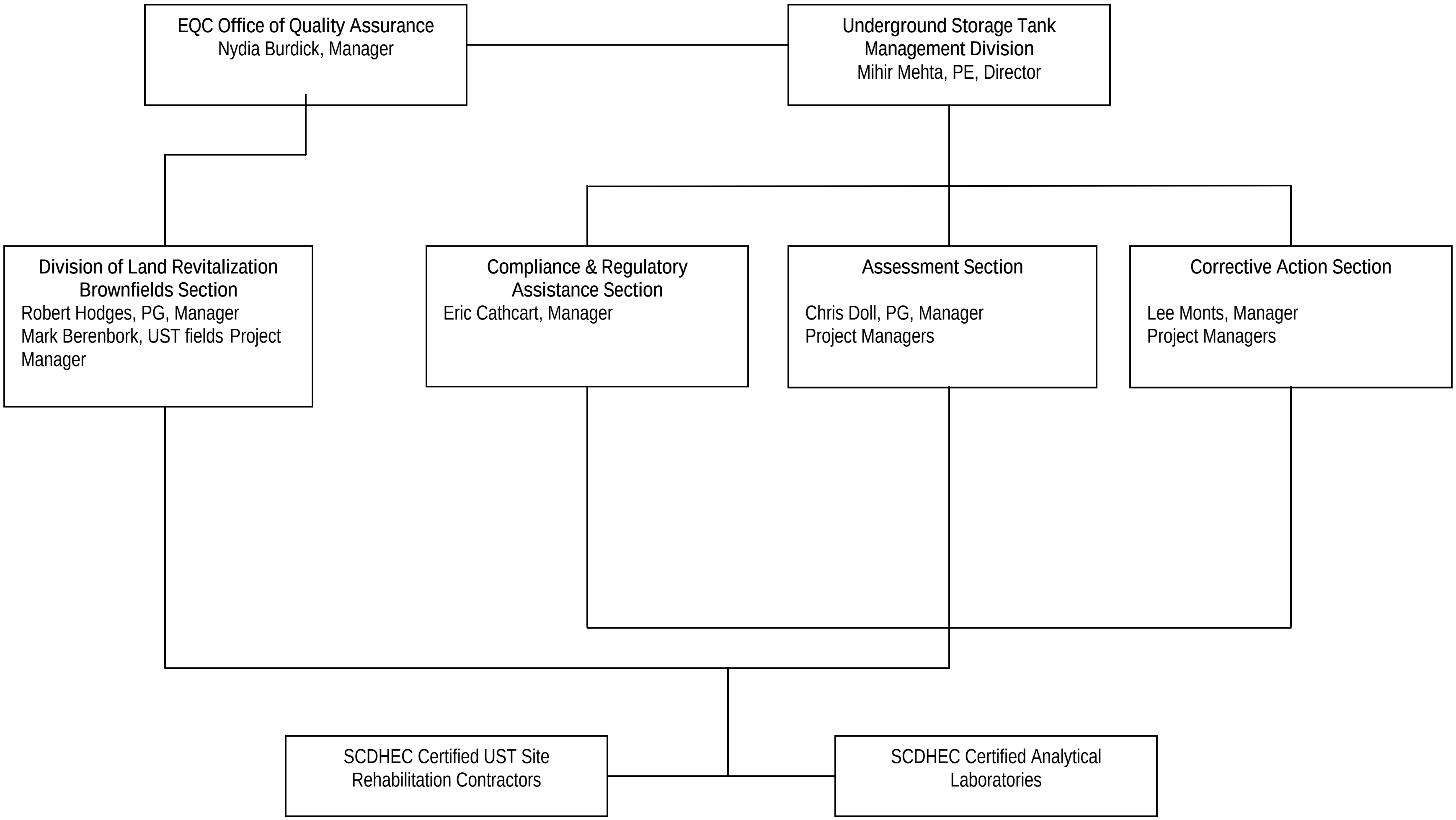


Figure 1 Organizational Chart

A5 Problem Definition/Background

Approximately 9,000 releases have been reported from regulated underground storage tanks (UST) in South Carolina. The UST Management Division addresses the chemicals released from leaking USTs. The petroleum chemicals of concern present in the soil and groundwater constitute potential risks to human health and to the environment and require investigation in order for decisions to be made regarding appropriate levels of site rehabilitation or possible closure. All such decisions must be technically defensible and must be protective of human health and the environment. It is the intent, and shall be the policy of, the UST Management Division to investigate all leaking UST sites in a consistent fashion, to ensure that the responsible party acts in an expeditious manner to perform the appropriate site assessment and, where circumstances dictate, designs a satisfactory remediation plan. The UST Management Division will utilize the decision-making flow chart in Appendix A in determining what actions need to be completed at a site.

It shall be the policy to treat each leaking UST site on a case-by-case basis. The Project Manager assigned to the site ensures progress on legal and routine actions, and decides on the degree of remediation required based on several factors. The primary factor to be considered will be whether a direct threat to human health or the environment currently exists. Such cases will receive top priority, and direct action will be taken to protect the public. Where necessary at a minimum, free phase product removal will be required wherever encountered. It shall be the goal of the UST Management Division to clean the groundwater to site-specific target levels based on current and all potential receptors as measured by the sampling of monitoring wells throughout the CoC plume.

Because every site will be treated on a case-by-case basis, the programmatic QAPP will be appended with specific site information. These appendixes will be developed by the contractor along with SCDHEC personnel. The Project Manager will ensure that all required information from the site is addressed in the addendum. Information will include a site map with the sampling sites indicated, the history of the site, the number of samples to be collected, when the sampling will take place, the Laboratory that will be used along with their SCDHEC Laboratory Certification Number, and who will collect the samples. The QAPP Addendum will be submitted to the UST Project Manager for approval at least 15 business days before sampling is to commence. The Addendum must be approved before site work begins. The UST Management Division in conjunction with the Office of Quality Assurance (OQA) has developed a format for these addendums. See Appendix B of this QAPP.

The policy of the UST Management Division is and will be to collect water and soil quality data that is scientifically valid, defensible, and of known accuracy. The UST Management Division presently uses existing guidance and the procedures outlined in this plan to ensure that investigations are accurately conducted and defensible in an administrative proceeding. Contractors certified by the Department to perform leaking UST investigations are required to submit a QA/QC plan and a site-specific Quality Assurance Project Plan (QAPP) based on EPA QA/R-5 and this document, the UST Programmatic QAPP, prior to engaging in site activities.

A6 Project Description

The Programmatic QAPP for the UST Management Division is presented in this document and describes the plan of action for South Carolina leaking UST site activities. Some specific site activities which will generate and/or affect environmental data include soil and water sample collection and analysis; soil boring and monitoring well installation; decontamination procedures; groundwater, geophysical, and other survey measurements; and data reduction and analyses. Site-specific QAPPs will present information specific to the site including location, topography, work schedules including the start and completion dates, and resource constraints.

All releases are prioritized in accordance with the ranking system outlined in Step 2 Site Priority Classification below. Releases qualified for funding from the SUPERB Account are funded in order of relative risk based upon availability of funds in the SUPERB Account. All other releases are investigated as rapidly as possible, depending upon the tank owner's ability to conduct necessary site rehabilitation activities. Each of the releases is unique depending on its components, the type of product stored, the local hydrogeologic conditions and the history of the release. In addition, releases exist in virtually every type of South Carolina community, ranging from rural to metropolitan. At any South Carolina facility where a leak from a UST has occurred, the staff of the UST Management Division is responsible for ensuring that all site activities are performed in accordance with the quality assurance procedures and requirements of this QAPP.

Initial investigations are conducted using standardized scopes of work (Initial Groundwater Assessment, Tier I Assessment) that provide sufficient data on the extent and severity of contamination and the location of proximate potential receptors to allow preliminary ranking of the risk presented by a release and determination of subsequent scopes of work. Comprehensive investigations of releases that will require site rehabilitation are conducted in accordance with the Tier II Assessment work scope. The Tier II work scope provides a systematic approach to obtaining all of the data necessary to fully characterize the extent and severity of a release and determine its potential risk to human health and the environment. The site rehabilitation process outlines the data gathering necessary to document the progress and completion of site rehabilitation for petroleum releases. The UST Management Division will utilize a decision-making flow chart (Appendix A) to determine what scope of work is to be conducted at a site. On any course of action involving sample collection, the UST Contractor will be required to submit an addendum to this QAPP specifying site related information (see Appendix B). This information will include site selection, work schedules, geographical locations, and time or resource constraints since this information is so specific for each project/site.

These and all other pertinent site activities that will generate environmental data will be subject to QAPP requirements. Potential uses for collected environmental data include estimating of the magnitude and extent of contamination, characterization of site conditions for development of remedial action procedures, and documentation of effectiveness of remediation.

The primary goal of the quality assurance program outlined in this document is to ensure that all data generated by or for the SCDHEC UST Management Division which relates to UST site activities will be scientifically valid, legally defensible, and of known and acceptable precision and accuracy. Specific objectives of the quality assurance procedures include the following:

- All data generated for or by the UST Management Division will be of sufficient or greater quality to withstand scientific and legal challenge

- The intended use of all data will be determined before data collection efforts begin to ensure that the necessary levels of data quality are attainable
- All sample collections and analysis are project specific and will be defined in investigation work plan
- All data produced for or by the UST Management Division will be of known and acceptable precision, accuracy, representativeness, completeness, and comparability.
- All projects will receive adequate supervision by the UST Management Division staff to ensure quality data is collected

The UST Management Division will track the progress of work at UST sites through monitoring reports. Generally, groundwater monitoring is required on a quarterly or semiannual basis. Groundwater monitoring and reporting frequencies are adjusted in some cases depending on the severity of the groundwater contamination.

Below is a list of events that must take place for each type of work beginning with the Initial Ground Water Assessment through the Tier II Assessment. Actual project dates will be included in the Contractor's Amendments.

Risk-Based Corrective Action (RBCA) Procedures:

In response to releases from USTs, owners/operators must take certain initial abatement steps: prevent further releases, control fire and explosion hazards, and remove free product pursuant to the UST Control Regulations, R. 61-92. Investigation plans, RBCA evaluation reports, Site Rehabilitation Plans, and Engineering Reports must be approved by SCDHEC, as necessary, and in accordance with applicable guidance and regulations. All site rehabilitation activities related to UST releases must be performed by a SCDHEC certified site rehabilitation contractor as required by the State Underground Petroleum Environmental Response Bank (SUPERB) Fund Access and Site Rehabilitation Regulations, R. 61-98.

THE RBCA PROCESS

The RBCA process is depicted in Appendix A. This flow chart is an illustrated decision making process based on both observation and data from the site of the Leaking UST. This decision making process is based on the extent of the contamination of the Leaking UST as well as the impact to human health. Below the steps of the RBCA Process are laid out in text form and includes a discussion of what elevates the site from "no further action required" to a Tier I or Tier II Assessment.

1 - SITE ASSESSMENT

The information necessary for determining if emergency action is appropriate and for comparing concentration of CoCs to the RBSL must be obtained. The Initial Ground-Water Assessment (IGWA) and Tier I Assessment work scopes outline the minimum information necessary for completion of soil and groundwater assessment and a Tier 1 risk evaluation. In general, the information to be obtained during the Tier 1 evaluation may include:

- A review of historical records of site activities and past releases;

- Quantification of the CoC in soil and groundwater.

For petroleum releases, based on toxicity, mobility, persistence, and presence in material released, selected CoCs are:

For all gasoline, diesel, kerosene: benzene, toluene, ethylbenzene, xylenes, MTBE, 1,2-Dicholoroethane, PAH's (total naphthalene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)flouranthene, chrysene, and dibenz(ah) anthracene), oxygenates (Ethyl tert-butyl ether, 3.3-Dimethyl-1-butanol, tertiary-amyl methyl ether, diisopropyl ether, tert-butyl formate, tert-butyl alcohol, tert-amyl alcohol, and ethanol). EDB and lead will be investigated if tanks were in operation prior to 1991.

For used oil add: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver;

- Quantification of biological indicator parameters such as dissolved oxygen, nitrate, ferrous iron and sulfate;
- Location of primary source(s) of CoCs: - USTs, product lines, dispensers, service bays, etc.;
- Location of secondary source(s) of CoCs: - free-product, soil with concentrations above RBSLs, etc.;
- Location of maximum concentration of CoCs in soil and ground water;
- Determination of regional or site-specific hydrogeologic conditions (e.g., depth to ground water, flow direction, gradient, ambient ground water quality, ground-water flow velocity);
- Location of current and reasonable future receptors within 1,000 feet of the site. All drinking water wells within a radius of 250 feet of the site for Initial Groundwater Assessment, 500 feet of site for Tier I Assessment, and 1,000 feet for Tier II Assessment shall be sampled for appropriate CoCs;
- Identification of potential significant transport and exposure pathways. A complete exposure pathway includes: 1) a source and mechanism for CoC release into the environment, 2) a transport medium (e.g., air, soil, ground water, vapor migration through soil and utilities) for the CoC to move from the source to the receptor, 3) a point of potential contact of the receptor with the medium (points of exposure such as drinking water wells, surface water bodies), and 4) an exposure route or means for taking the CoC into the body (e.g., ingestion, inhalation, dermal contact);

For non-petroleum releases, based on toxicity, mobility, persistence, and presence in the material released, CoCs will be established on a case-by-case basis.

Determination of current and reasonably anticipated future use of the property, ground water, surface water, and sensitive habitats for the site and adjacent properties. Use of property shall be determined based on factors such as: zoning laws; comprehensive infrastructure such as transportation and public utilities; site location in relation to urban, residential, commercial, industrial, agricultural, and recreational areas; Federal/State land use designation; historical or recent development patterns; and location of wellhead protection areas;

- Documentation, if available, of the changes in concentration of CoCs over time (i.e., stable, increasing, decreasing);

- Documentation, if appropriate, of concentration of CoCs measured at point(s) of exposure (e.g., concentration of CoCs in a nearby drinking water well, vapor concentration of CoCs in nearby utilities); and

- Collection of air or water quality samples, as appropriate, from any receptor (well, underground structure, water body) that has a potential of being impacted by virtue of its proximity to the source.

2 - SITE PRIORITY CLASSIFICATION

Based on initial release information and subsequently upon completion of each tier evaluation, the release is classified by DHEC into categories based on the current and projected degree of risk to human health and the environment. Prioritization/classification is an on-going process based on available information. Releases may be reclassified subsequent to abatement, further assessment information, and remedial actions. Typical release scenarios and response actions to eliminate any immediate threat are provided in Table 3. Emergency Action to eliminate immediate exposure is required. The Underground Storage Tank Management Division should be notified at (803) 896-6241 or, when necessary, an emergency can be reported directly to the Emergency Response Program at 1-888-481-0125 or (803) 253-6488. Appropriate actions must be implemented as soon as possible to eliminate an immediate threat.

Classification 1: The highest priority classification is for those releases that pose an immediate threat to human health and the environment. Sites are placed in Classification 1 if:

- An emergency situation exists
- A fire or explosion hazard exists
- Vapors or free product exists in a structure or utility
- Concentrations of CoC have been detected in a potable water supply or surface water supply intake
- Free product exists on surface water
- CoC exists in surface water

Classification 2: is the second priority classification. This Classification is for those releases that pose a significant near term (0 to 1 year) threat. This Classification is further subdivided into 2a and 2b. Sites are place in Classification 2 if:

Classification 2a:

- A significant near term (1 to 1 year) threat to human health, safety, or sensitive environmental receptors exists
- Potable supply wells or surface water supply intakes are located < 1-year ground water travel distance downgradient of the source area.

Classification 2b:

- Free product exists in a monitoring well at a measured thickness > 1 foot.
- Potable supply wells or surface water supply intakes are located < 1000 feet downgradient of the source area (where ground-water velocity data is not available.

Classification 3: The third priority classification is for those releases where there is a short-term (1 to 2 years) threat. This is also subdivided in to 3a and 3b. Sites are placed in Classification 3 if:

Classification 3a:
- A short-term (1 to 2 years) threat to human health, safety, or sensitive environmental receptors exists.
- Potable supply wells or surface water supply intakes are located > 1year and < 2 years ground-water travel distance down-gradient of the source area.
- Sensitive habitats or surface water exist < 1 year ground-water travel distance down-gradient of the source area and the ground water disc

Classification 3b:
- Free product exists in a monitoring well at a measured thickness > 0.01 feet.
- Concentrations of CoC above the RBSL have been detected in a non-potable water supply well.
- Hydrocarbon-containing surface soil (< 3 feet below grade) exists in areas that are not paved.
- Sensitive habitats or surface water used for contact recreation exist < 500 feet downgradient of the source area (where ground-water velocity and discharge location data are not available).
- The site is located in a sensitive hydrogeologic setting, determined based on the presence of fractured or carbonate bedrock hydraulically connected to the impacted aquifer.
- Ground water is encountered <15 feet below grade and the site geology is predominantly sand or gravel.

Classification 4: the fourth priority classification is for those releases where there is a long-term (> 2 years) threat to human health or the environment. This Classification is also subdivided into 4a and 4b. Sites are put in Classification 4 if:

Classification 4a:
- A long-term (>2 years) threat to human health, safety, or sensitive environmental receptors exists.
- Potable supply wells or surface water supply intakes are located > 2 years and < 5 years ground-water travel distance, downgradient of the source area.
- Non-potable supply wells are located < 1 year ground water travel distance downgradient of the source area.

Classification 4b:
- Free product exists as sheen in any monitoring wells.
- Non-potable supply wells are located < 1000 feet downgradient of the source area (where ground water velocity data is not available).
- The ground water is encountered < 15 feet and the site geology is predominantly silt or clay.

Classification 5: The fifth priority classification is for releases that do not meet any of the characteristics of the earlier priorities, or where there is no current demonstrable threat to human health or the environment but where data indicate CoC concentrations are above the RBSLs and further assessment is needed. Groundwater travel times are calculated from the monitoring well closest to the exposure point that contains concentration of CoCs above the RBSLs. Sites are placed in Classification 5 if:

- There is no demonstrable threat, but additional data are needed to show that there are no unacceptable risks posed by the site.
- Assessment data for the site indicate concentrations in some samples are above the RBSL or SSTL, as appropriate and further assessment is needed.
- Assessment data for the site indicate concentrations in sample are below the RBSL or SSTL, as appropriate, but he samples are determined not to be representative, therefore, further assessment is needed.

Scenario	Potential Initial Response
Explosive levels or concentrations of vapor are present in a residence or other building	Evacuate occupants; begin abatement measures such as ventilation.
Explosive levels are present in the subsurface utility system	Evacuate immediate vicinity; begin abatement measures such as ventilation.
Free-phase product is present in significant quantities at ground surface, on surface water bodies, or in utilities.	Prevent further free-phase product migration, institute recovery, monitor vapor concentrations.
An active water supply well, water supply line, or public water is impacted or immediately threatened.	Notify users, provide alternate water supply, and treat water point of use.
A sensitive habitat or sensitive resources are impacted.	Minimize extent of impact by containment measures and implement habitat management to minimize exposure.

Table 3 Potential Initial Response Actions to Eliminate Immediate Threat for Typical Release Scenarios

TIER 1 EVALUATION

Data obtained from a Tier I Assessment requires three sub-steps to complete the Tier 1 Evaluation: 1) comparison with the RBSL, 2) the development of a site conceptual exposure model, and 3) identification of data required to characterize the complete and potential pathways identified in the site conceptual exposure model. A complete exposure pathway exists where a mechanism allows a receptor to be exposed to the CoC.

Data obtained from an IGWA allows comparison of CoC concentrations to the soil and ground water RBSLs to determine if additional a Tier 1 or Tier 2 evaluation is required.

1 - Comparison with RBSL

For a Tier 1 Risk Evaluation, it is assumed that all exposure points are located in or near the source area.

CoC concentrations should be compared with the values provided in the RBSL Look-Up Tables in Appendix C for the ground-water ingestion, soil leaching to ground water, vapor inhalation, and soil ingestion pathways. For other chemicals of concern not included in Appendix C, the RBSLs may be calculated based on a carcinogenic risk of 10^{-6} and a hazard index of 1. As the toxicity of Total Petroleum Hydrocarbon (TPH) analyses cannot be quantified, it cannot be used in the risk decision-making process. Each CoC is evaluated separately for each exposure route, as SCRBCA does not consider the additive effect of risk from different CoCs and different routes of exposure.

Representative concentrations of CoCs in affected media are determined by the following:

- Air: The maximum CoC vapor concentration obtained during the most recent sampling event should be used. Historical sampling events can be used to establish trends.

- Ground Water: The maximum CoC concentration obtained during the most recent sampling event should be used. Historical sampling events can be used to establish trends.

- Soil: The maximum CoC concentration obtained during the last sampling event should be used for the ingestion and dermal contact pathways. For the soil leaching to ground water pathway, the average of two soil sample results or highest single sample with the highest non-zero concentrations from each source will be compared with RBSLs.

2 - Site Conceptual Exposure Model

A site conceptual exposure model uses information about the following to identify all complete and potential exposure pathways:

Release information:

- Pertinent release information may include, but is not limited to: the historical use of the property where the release occurred, the approximate age of the release, and the properties of the CoC (e.g., solubility, volatility) that were released.

Characteristics of the site:

- Pertinent site characteristics may include, but are not limited to: geology to include the soil type, depth to bedrock, depth to groundwater, bulk density, porosity, water content, hydraulic gradient, ground-water flow direction, seepage velocity, fractional organic carbon and the physical distribution of each CoC around the source.

Proximity of potential receptors and their characteristics:

- The construction specifications (e.g., depth, diameter, and material of construction of a private well or storm sewer) of all potential man-made receptors should be identified.
- Location of all natural receptors (e.g., rivers, lakes, marshes, etc.) within 1,000 feet.
- Current land use of all affected properties:

- For each property that is impacted, may potentially become impacted, or is adjacent to a potentially impacted property, the current land use should be identified (e.g., vacant lot, restaurant, school, residence, factory).

Applicable zoning or land use ordinances:

- The local city or county administrative authorities should be contacted for information pertaining to any restrictive zoning and land use ordinances. Zoning ordinances set broad-scale restrictions on property development such as residential, commercial, or industrial. Land use ordinances may establish smaller scale restrictions such as disallowing the installation of drinking water or irrigation wells. A photocopy of the applicable sections of the ordinances should be provided. If a copy cannot be obtained, the ordinance number and the name, phone number, and business address of the appropriate city or county authorities should be provided with the relevant information.

Based on the estimated age of the release, known distribution of the CoCs, and the potential for migration, all complete and potential exposure pathways should be identified and summarized for land use (current and future conditions). For example, drinking water wells may not currently exist but ground water may reasonably become a source of irrigation or drinking water. The following potential exposure pathways should be considered for evaluation:

- Air
  - inhalation of ambient vapors
  - explosive hazard

- Surface Water (e.g., lake, river, stream, ditch, marsh)
  - ingestion
  - dermal contact
  - volatile inhalation

- Ground Water
  - ingestion
  - dermal contact
  - volatile inhalation

- Surficial Soil (impacted soil located <3 feet below land surface or exposed at surface)
  - ingestion
  - dermal contact
  - volatile inhalation
  - leaching to ground water

- Subsurface Soil (impacted soil located >3 feet below land surface)
  - ingestion (during excavation)
  - dermal contact (during excavation)
  - volatile inhalation (during excavation)

– leaching to ground water

Exposure routes and pathway summarization for the site conceptual model are shown in Appendix D.

3 - Identify Data Requirements

For each complete or potential exposure pathway identified in the site conceptual model, identify the data necessary to characterize the migration potential along the pathway and to quantify the potential impact. For example, if the accumulation of vapors in a utility is a concern, data may be appropriate to characterize the transport of the CoC from the source to the utilities via ground water, the extent of volatilization from the ground water, the transport of vapors from the ground water to the utility, and the construction specifications (material of construction and types of seals) of the utility. These data requirements would then become an integral part of a Tier II assessment. The site conceptual model format for various media of exposure should be summarized in the tables given in Appendix D and included in the final report as required in Section A9 of this document.

TIER 1 ACTION

Once the Tier 1 evaluation or Tier I assessment is completed, three decision options are available for consideration based on the CoC concentrations:

1 - No Further Action

If the representative concentrations (please see step 3 for an explanation of the representative concentrations) of the CoCs are below the RBSLs, further assessment and/or cleanup is not necessary. Please see the no further action option in Step 13.

2 - Emergency Action

Typical release scenarios and response actions to eliminate any immediate threat are provided in Table 3. Emergency Action to eliminate immediate exposure is required. The Underground Storage Tank Management Division should be notified at (803) 896-6241, or when necessary, an emergency can be reported directly to the Emergency Response Program at 1-888-481-0125 or (803) 253-6488. Appropriate actions must be implemented as soon as possible to eliminate an immediate threat.

3 – Concentration above RBSLs

If the concentrations of the CoCs are above the RBSLs, a Tier 2 investigation using a Tier II Assessment is warranted under the following conditions:

- If the SSTL developed under the Tier 2 investigation are anticipated to be significantly different from the Tier 1 RBSL (concentration of CoC exceeds the RBSL but it is predicted that the use of site-specific data will allow different site-specific cleanup goals to be determined);

- If the cost of remedial action to reach RBSL will likely be greater than Tier 2 evaluation (data collection, analysis, review, etc.) and subsequent remedial action;
- Free phase product is present; and
- The approach or assumptions used to derive the Tier 1 goals are not appropriate for conditions at the site.

TIER II ASSESSMENT

If Tier II assessment is warranted to fully evaluate the current and future exposure pathways identified in the site conceptual model, a Tier II Assessment Plan to conduct a Tier 2 evaluation should be submitted. A Tier II Assessment includes:

- determination of geology;
- determination of the site-specific hydrologic conditions;
- determination of extent of free-phase product;
- determination of horizontal and vertical extent of each CoC above the RBSL, as appropriate;
- determination of changes in concentrations of each CoC over time (i.e., increasing, stable, or decreasing with time);
- determination of concentrations of each CoC measured at exposure points (e.g., in a nearby drinking water well, vapor concentration of nearby utilities); and
- evaluation of fate and transport of each CoC.

Additional site assessment may be required to fully evaluate the current and future exposure pathways identified in the Tier 1 evaluation. The Tier II Assessment document outlines a comprehensive site assessment approach for obtaining the additional information necessary for a Tier 2 evaluation.

TIER 2 EVALUATION

The Tier 2 risk evaluation consists of three sub-steps: 1) establishing exposure point(s), 2) establishing the site-specific points of compliance, and 3) calculating the corresponding SSTL for each CoC for identified points of compliance and verification.

1 - Establish the exposure point(s)

An exposure point is that point at which it is assumed that a receptor (either actual or potential) can currently or in the future come in contact with the CoC. Exposure points may include, but are not limited to:

- private and public water supply wells;
- irrigation wells;
- surface water bodies (e.g., lakes, streams, rivers);
- sensitive habitats (e.g., wetlands, fisheries, shellfish areas); and
- underground utilities, building basements, etc.

Note: All current or future exposure pathways should be considered for each CoC.

An exposure pathway is the course that the CoC takes from the source to a receptor. To determine if the pathway is complete, the Tier 2 Risk Evaluation must provide sufficient information to identify the source and the transport mechanisms to the exposure point. For example, if a CoC reaches an underground utility, the construction material (e.g., PVC, ductile iron, etc.) of the underground utility and the types of seals (e.g., glue, neoprene, etc.) at the pipe couplings should be identified and used to determine if a potential exists for the CoC to enter those lines resulting in an exposure to the receptor. However, if utilities are at three feet below land surface and groundwater is at 35 feet, a complete exposure pathway probably does not exist. For a given medium and exposure route, if a risk does not exist for a selected pathway then the exposure point should not be further evaluated.

For the ground water ingestion pathway, the exposure point must be established based on current and reasonably anticipated future use of the ground water. Table 4 gives examples of exposure points for various possible situations. Please refer to STEP 3 Site Conceptual Exposure Model for details on how to identify if the adjacent property is a possible exposure point.

2 - Establish Point(s) of Compliance

A point of compliance is a location selected between the source area (area of maximum concentrations) and the exposure point where the concentration of each CoC must be at or below the Compliance Point Concentration (CPC). Typically the CPC is between the SSTL at the source area and RBSL applied at the exposure point. Points of compliance should be established down gradient of the source area but hydraulically up gradient of an exposure point. At least one point of compliance must be located between the source area and the exposure point for each completed pathway, with a minimum of one-year travel time for the CoC from the point of compliance to the exposure point. Additional point(s) of compliance are necessary where complex hydrogeological conditions exist that may control CoC migration.

When establishing point(s) of compliance the following factors must be considered:

- locations of current receptors;
- locations of potential receptor(s);
- current and projected land and resource usage; and

- velocity of the CoC in soil, ground water or air.

Site Status	Down gradient offsite property status	Exposure Point should be located	Figure
Actual or potential source of water	Source of water or not	At source area	2a
Within the radius of influence of a pumping well	Source of water or not	At the edge of the well's radius of influence	2b
No Exposure Point on the property	Off site is a source of water	Closest offsite property boundary	2c
No Exposure Point on the property	Off site is not a source of water	Hydraulically up gradient of a potential receptor	2d

Table 4 Choice of Exposure Points

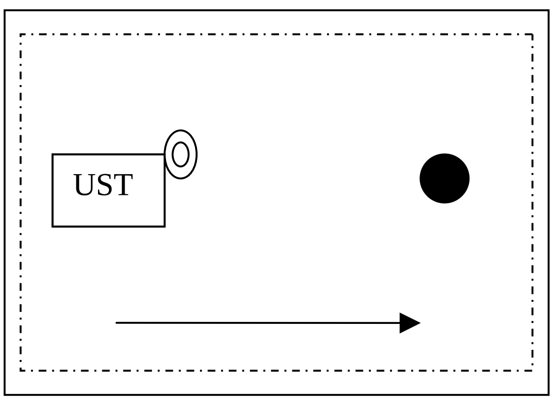


Figure 2a

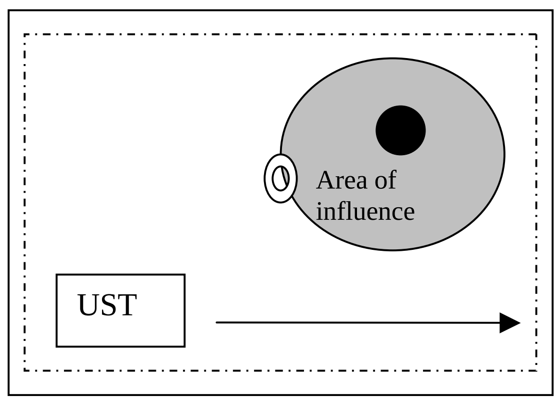


Figure 2b

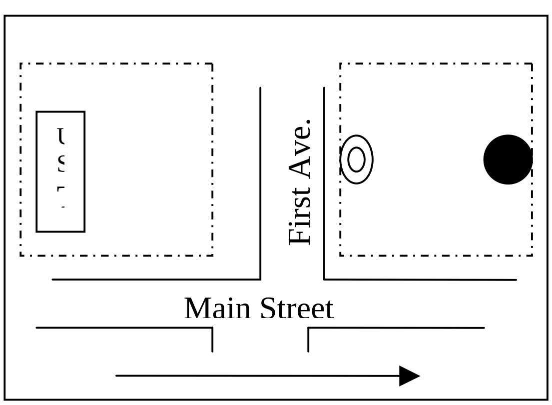


Figure 2c

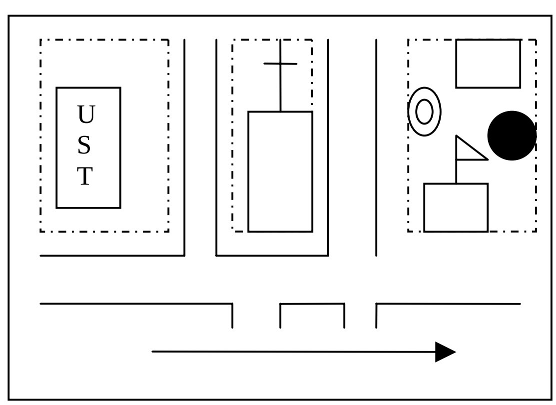


Figure 2d

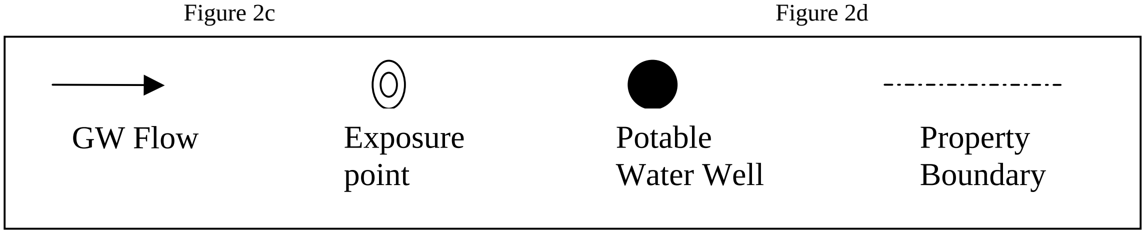


Figure 2 Figures of Exposure Points

3 - Establish the SSTL

Site-specific target levels should be established for each CoC and each particular pathway identified in the site conceptual model based on the spatial and temporal (both measured and predicted) attenuation of the concentration of each CoC above the RBSL. All possible scenarios must be evaluated during this process utilizing simple fate and transport models. Input data can be limited to site-specific data attainable through standard industry practices. All assumptions must be listed and fully explained.

The following steps should be followed to complete the Tier 2 evaluation:

- For the soil leaching to ground water pathway, the SSTL for soil can be calculated using the leachability model provided in Appendix G. Following the method described below, it may be appropriate to first calculate the SSTL for the ground water pathway before using the leachability model. The soil SSTL must be protective of the estimated SSTL for ground water.

- For the ground water ingestion pathway, there are two methods that can be used to estimate the reduction of CoC in the saturated zone: i) using empirical data and ii) models implemented with site-specific data.

- In a case where the CoC plume is shown to be stable or shrinking (by monitoring data), empirical data can be used to approximate the Concentration Reduction Factor (CRF) of the CoC in the relevant medium from the source to exposure point. For example, if the concentration of benzene in source area is 100 micrograms per liter (µg/L) and the actual measured non-zero concentration in the most down gradient monitoring well is 10 micrograms per liter (µg/L), and then benzene has been documented to be reduced by a factor of 10 (i.e., the CRF is 10). The SSTL = RBSL X CRF. Since the ground-water RBSL for benzene is 5 µg/L to be applied at the exposure point, the SSTL for ground water to be met at the source area is (5 µg/L * 10) =50 µg/L.

- Fate and transport models can also be used to calculate the SSTLs. SSTLs are typically calculated by calibrating the model using actual measured site-specific data and then, increasing or decreasing the concentration in the source area until the concentration at the receptor will not exceed the RBSL. For sites with site-specific conditions that may warrant a more complex analysis, it may be appropriate to utilize computer models such as Bioscreen, Solute, AT123D, Bioplume II, and other applicable models to calculate the SSTLs. All assumptions made must be valid and the input parameters, along with explanation for their choice, must be provided with the modeling results.

- For other chemicals:
    - In a Tier 2 evaluation, SSTLs for the dermal contact, soil and ground water ingestion and vapor inhalation pathways shall be based on a carcinogenic risk limit of 10^{-6} and a hazard index of 1 for non-carcinogens to be applied at the exposure point. Each chemical is evaluated separately for each exposure route, as SCRBCA does not consider the additive effect of risk from different chemicals and different routes of exposure. The state toxicologist will be consulted as necessary to provide recommended exposure limits.

TIER 2 ACTION

Once the Tier 2 evaluation is completed, three decision options are available for consideration based on the CoC concentrations:

1 - Monitored Natural Attenuation Action

If the representative concentrations (see STEP 3) of the CoCs are below the SSTLs, further CoC delineation is not necessary. A CAP proposing a short-term (e.g., 18 months or less) monitoring program to verify natural attenuation should be submitted. The Site Rehabilitation work scope describes the details of demonstrating natural attenuation.

2 - Active Corrective Action

If the concentration of the CoCs are above the SSTLs and Tier III assessment is not considered an appropriate option, Site Rehabilitation to achieve Tier 2 SSTLs should be recommended. Free-phase product must be removed to the extent practicable pursuant to R.61-92, Section 280.64.

If the concentrations of the CoCs are above the SSTLs, Tier 3 evaluation is warranted under the following conditions:

- If the SSTLs developed under Tier 3 evaluation are anticipated to be significantly different than the Tier 2 SSTLs (i.e., concentrations of CoC exceed the SSTLs but it is predicted that the use of site-specific biodegradation data will allow different site-specific cleanup goals to be determined);

- If the cost of remedial action to Tier 2 SSTL will likely be greater than Tier 3 evaluation (data collection, analysis, review, etc.) and subsequent remedial action; and

- The approach used to derive the Tier 2 goals is not appropriate for conditions at the site.

3 - TIER III ASSESSMENT

In a Tier III, SSTLs for the source area and the point(s) of compliance are developed on the basis of more sophisticated statistical and CoC fate and transport analyses using site-specific input parameters for appropriate exposure scenarios. Any additional information required for site-specific modeling efforts should be proposed in a Tier II Assessment Plan.

TIER 3 EVALUATION

The Tier 3 evaluation involves the use of more sophisticated mathematical models than those used in Tier 2 (e.g., computer analytical models) or numerical ground-water modeling codes that predict time dependent dissolved CoC transport under conditions of spatially varying permeability fields to predict exposure point(s) concentrations and to re-calculate SSTLs based on more site-specific data. Monte Carlo models, which allow a range of fate and transport scenarios to be calculated, may also be appropriate. Less conservative site-specific exposure factors can be used in calculations for commercial and industrial sites if pre-approved by the Department. All assumptions, methods and models must be submitted for pre-approval.

TIER 3 ACTION

Once the Tier 3 evaluation is completed, two decision options are available for consideration based on the CoC concentrations:

1 - Monitored Natural Attenuation (MNA) Action

If the concentrations of the CoCs are below the SSTLs, further CoC delineation is not necessary. A CAP proposing a short-term monitoring program to verify natural attenuation should be submitted. The Site Rehabilitation work scope describes the details of demonstrating natural attenuation.

2 - Active Corrective Action

If the concentrations of the CoCs are above the SSTLs, an active cleanup to achieve Tier 3 SSTLs should be recommended.

SITE REHABILITATION (ACTIVE OR MNA)

The selected active Site Rehabilitation methodology must be designed to achieve SSTLs for each CoC. An appropriate monitoring program will be required to ensure that the target goals continue to be met and the receptor(s) are protected. Once the SSTL for every CoC is achieved, a verification-monitoring program to demonstrate natural attenuation should be implemented. Please refer to the Site Rehabilitation work scope for details. Departmental approvals and/or permits are required for all CAPs, air and water discharges, underground injection, etc. Detailed design specifications must be developed for installation and operation of above ground remediation systems. All planned Site Rehabilitations, whether active or MNA, will be placed on public notice as required by the SCUSTCR (R.61-92, 280.66) to allow potentially affected parties to participate in the Site Rehabilitation decision-making process.

VERIFICATION MONITORING FOR MONITORED NATURAL ATTENUATION

During or following a Site Rehabilitation, a compliance monitoring program may be required to ensure that the target goals continue to be met and the assumptions and predictions used in Tier 2 and 3 are verified. In order to reach these goals, appropriate monitoring parameters (organic and inorganic, as necessary), frequency of monitoring, and monitoring methods will be established based on site-specific requirements. Once monitoring data support the conclusion that the contaminant plume has reached equilibrium or is not moving at a significant rate; that concentrations of CoCs are not increasing; that no unacceptable to risk to human health, safety, or the environment exists; and that the CoCs will naturally attenuate over time, no further action under SCRBCA is necessary.

NO FURTHER ACTION DECISIONS

No further action (NFA) decisions will be issued by the Department for underground storage tank releases where additional site rehabilitation actions are not required. An NFA is issued where each CoC for soil, vapor or ground water has decreased to the RBSL. A Conditional No Further Action (CNFA) may be issued upon the Department's concurrence that the petroleum CoC concentrations are less than SSTLs but still greater than the RBSLs. Such decisions can be reached only when verification monitoring documents that natural attenuation is taking place, and that no risk to human health or environment will result. For example, if concentrations of CoCs are present but below SSTLs in the ground water in areas where human consumption is prevented by local ordinances, then no further actions are necessary and a CNFA may be issued. Again, this decision is based on the demonstration that the release does not pose a risk to human health or the environment. The Department's CNFA decision will be issued in writing to the owner/operator and all assumptions and conditions will be outlined (e.g., the ground water should not be used for consumption). A registry of releases will be maintained in the SCDHEC Freedom of Information office and the Bureau of Land and Waste Management Website to assist the public and document the status of release(s). This registry will identify the location of the UST release, the affected property (or properties), and the assumptions and conditions of the CNFA. If the Owner/Operator provides information to support that the concentrations associated with the release are at levels below risk-based screening levels for all the CoCs of concern at a facility where a CNFA has been issued, then the release will be given a NFA.

Scope of Work for the Initial Groundwater Assessment, Tier I Assessment, and Tier II Assessment

Work to be done for the Initial Groundwater Assessment (IGWA) Assessment:

1. Location of all private and public water supply wells (drinking and non-drinking) and other potential receptors (as defined in the Risk Based Corrective Action (RBCA) Procedures Section) within a 1000-foot radius of the site.
    a. Document the locations in the Report of Findings and depict the locations on the relevant portion of the appropriate US Geological Survey 7.5 min topographic map. The map should be included as Figure 1 in the submitted report. Map scale should be 1 inch = 300 feet.
    b. Immediately upon locating any receptors screen them for hydrocarbons using a properly calibrated screening device. (See Section B1)
    c. Obtain water samples for all water supply wells and surface water bodies within a 250-foot radius of the site. All municipal supply wells within a 1000 foot radius shall also have a sample collected and analyzed for the appropriate parameters (See Section B1)
    d. Notify the UST project manager at (803) 896-6241 as soon as possible if any water samples are collected within a 1000-foot radius so that the approved SUPERB agreement can be amended.
    e. If field screening indicates the presence of hydrocarbons notify the UST project manager at (803)-896-6241 within 48 hours of detection and provide the name, address and a contact telephone number for all affected property owners. All field-screening and laboratory data for these receptors shall be included in the Report of Findings.
2. Document the current use of the site and adjacent land as residential, commercial, agricultural, industrial, etc. Identify any UST site(s) within a 500-foot radius of the subject site and provide their UST permit number(s) in the Report of Findings.
3. Monitoring Well or Boring Installation (See Section B1)

4. Soil and Groundwater Sampling and Analysis (See Section B1)
5. Water and Soil Disposal – All solid, development water, and any purge water generated during assessment implementation shall be temporarily stored in 55-gallon drums or a similar container. Upon receipt of laboratory analytical results, the soil and/or water shall be properly disposed of in the appropriate manner. The Contractor's Addendum shall state specifics.

Work to be done for Tier I Assessment:

The Tier I Assessment shall be conducted at sites where a release of petroleum from a regulated UST has been confirmed and additional information is necessary to further categorize the release (See Appendix A for flow chart).

1. Location of all private and public water supply wells (drinking and non-drinking) and other potential receptors (as defined in the Risk Based Corrective Action (RBCA) Procedures Section) within a 1000-foot radius of the site.
    a. Document the locations in the Tier I Assessment Report and depict the locations on the relevant portion of the appropriate US Geological Survey 7.5 min topographic map. (Include as Figure 1 in submitted report)
    b. Screening receptors (see Section B1)
    c. Water Samples (see Section B1)
2. Document the current use of the site and adjacent land as residential, commercial, agricultural, industrial, etc.
    a. Include a summary of all zoning regulations concerning the installation of drinking and/or irrigation wells or land use. If no zoning regulations exist, the nearest property boundaries within 1000 feet of the UST shall be identified.
        i. Include names and phone numbers of any persons that have provided information pertaining to land use or zoning ordinances, statutes, and/or regulations as Appendix H of the Tier I Report (See Section A9)
    b. Obtain a copy of the applicable portion of a tax map which depicts the location of the facility, the release area, and all properties located adjacent to the impacted areas including active and former gas stations with permit numbers (if available). The tax map and names and addresses of owners of each of the properties must be provided as Appendix C of the Tier I Report. (See Section A9) Additionally, the names, address, and daytime phone number will be provided for all owners of private wells. The private wells will be shown in the correct location of the tax map.
    c. Locate and report all underground utilities (gas electrical, telephone, water, Cable TV, storm drain and sewer lines) within a 250-foot radius of the UST facilities boundaries. These locations must be pinpointed to the nearest 1 foot horizontally and the depth to the nearest 2 feet. Depict all of these identified utilities on a surveyed map.
    d. Soil Boring and Monitoring Well Installation (See B1)
    e. Soil and Groundwater Sampling and Analysis (See B1)
    f. It is required that after completion of the Soil Boring/Monitoring Well installation that a survey of the UST facility shall be produced by a SC Licensed Professional Land Surveyor. This should be included as Appendix A (See Section A9) in the submitted report. This survey shall include all of the following:

   i. The location of all manmade structures,
   ii. All above ground and underground utilities,
   iii. All potential receptors on the site,
   iv. All existing and/or former USTs and associated piping and dispensers, and
   v. All monitoring wells within the survey area.

3. Tier 1 Assessment: The Tier I Assessment evaluates the actual and/or potential impact to receptors. Based on the data gathered from the fieldwork, a Tier 1 Risk Evaluation shall be completed. More detailed information may be found in the Risk Based Corrective Action (RBCA) Procedures Section.

   a. Compare the data with Risk Based Screening Levels (RBSL) - For a Tier 1 Risk Evaluation it is assumed that all exposure points are located in the source area. CoC concentrations shall be compared with the values provided in the Appendix C of this document, as appropriate. The following measurements of representative concentrations of CoC are to be utilized in this comparison:
      i. Air - The maximum CoC vapor concentration obtained during the last sampling event shall be used. Historical sampling events can be used to establish trends.
      ii. Groundwater - The maximum CoC concentration obtained during the last sampling event shall be used. Historical sampling events can be used to establish trends.
      iii. Soil - The maximum CoC concentration obtained during the last sampling event shall be used for the ingestion and dermal contact pathways. For the soil leaching to groundwater pathway, the average of the two soil sample results with the highest concentrations from each source area shall be used.
   b. Site Conceptual Exposure Model - The site conceptual model shall identify all complete exposure pathways. Information required to develop this model includes:
      i. Release information - Pertinent release information may include, but is not limited to, the historical use of the property where the release occurred, the approximate age of the release, and the properties of the CoC (e.g., solubility, volatility) that were released.
      ii. Characteristics of the site - Pertinent site characteristics may include, but are not limited to, the soil type, depth to groundwater, hydraulic gradient, groundwater flow direction, seepage velocity, and the physical distribution of CoC around the source.
      iii. Proximity of potential receptors and their construction - The construction specifications (e.g., depth, diameter, and material of construction of a storm sewer) of all potential receptors shall be identified.
      iv. Current land use of all affected properties - For each property that is impacted, may potentially become impacted, or is adjacent to a potentially impacted property, the current land use shall be identified (e.g., vacant lot, restaurant, school, residence, factory), and tax map submitted as part of the report.
      v. Applicable zoning or land use ordinances - The local city or county administrative authorities shall be contacted for information pertaining to any applicable zoning and land use ordinances. Zoning ordinances set broad-scale restrictions on property development such as residential, commercial, or industrial. Land use ordinances may establish smaller scale restrictions such as disallowing the

installation of drinking water or irrigation wells. A photocopy of the applicable sections or summary of the ordinances shall be provided. If a copy cannot be obtained, name, phone number, and business address of the appropriate authorities shall be provided with the relevant information.

c. Based on the estimated age of the release, known distribution of the CoC, and the potential for migration, all complete and potential exposure pathways shall be identified and summarized for land use (current and future conditions). The following potential exposure pathways shall be considered for evaluation:

Item	Potential Exposure Pathways
1. Air	- Inhalation of ambient vapors (particulate or volatile) - Explosive hazard
2. Surface Water	- Ingestion - Dermal contact - Volatile inhalation (enclosed space and outdoor)
3. Groundwater	- Ingestion - Dermal contact - Volatile inhalation (enclosed space and outdoor)
4. Surficial Soil	- Ingestion - Dermal contact - Volatile inhalation (particulate or volatile)
5. Subsurface Soil	- Ingestion (during excavation) - Dermal contact (during excavation) - Volatile inhalation (particulate or volatile) - Leaching to groundwater

Table 5 Potential Exposure Pathways

d. Identify Data Requirements - Identify the data necessary to characterize the migration potential, and to quantify the potential impact, for each complete, or potentially complete, exposure pathway identified in the site conceptual model above. Enter all identified data requirements in the Site Conceptual Model Tables (Appendix D) to be included in the Tier I Report (See Section A9).

e. Recommendations for Further Action - Utilizing the information above, a recommendation for the next appropriate action shall be made by the contractor submitting the report.

Work to be done for Tier II Assessment

The Tier II Assessment methodology is used for sites with petroleum releases from regulated underground storage tanks (USTs) where additional investigation of site-specific conditions is warranted based on existing data from previous investigations. Since previous investigations having indicated that the contamination has gone off site from the Leaking UST, Tier II Assessment attempts to discover the extent of the contamination horizontally and vertically. Thus, the number of wells and borings and placement of these are not specified in this QAPP. Rather the logic to determining where to site the borings/wells will be discussed.

Tier II Assessment Report Requirements and Responsibilities - All site rehabilitation activities related to a release from a regulated UST system require technical approval by the Department in accordance with applicable state directives. All site rehabilitation activities must be conducted by a SC Department of Health and Environmental Control (SCDHEC) Class I certified site rehabilitation contractor (the contractor) as required by the State Underground Petroleum Environmental Response Bank (SUPERB) Site Rehabilitation and Fund Access Regulations, R.61-98, whether reimbursement will be from the SUPERB Account or other financial mechanism. A qualified professional from the company or firm must sign and seal the Tier II Assessment Report and any other submittals that are based upon interpretation of data (e.g., monitoring well location plans) and their South Carolina PE or PG certification number and SCDHEC certified Class I site rehabilitation contractor number must be on the signature page of the report/submittal. All temporary and other monitoring wells must be drilled under the direction of a licensed class A, B, or C South Carolina Certified well driller. All laboratory analysis must be performed by a South Carolina certified laboratory for the specified parameters. All investigative derived waste must be handled within 90 days of generation in accordance with applicable state and federal regulations.

For offsite access, the contractor and/or UST owner/operator must obtain all off-site access agreements and/or encroachment permits necessary for investigation and well installation. The UST Management Division will assist in acquiring access if all efforts to gain access fail, and the tank owner/operator requests assistance from the UST Management Division in writing. When off-site access assistance is requested, the following items must be provided to the project manager:

1. The property identification to include the tax map number of the property, (e.g., 00020-304-10-01A), and 911 street address, (e.g., 201 South Main).
2. The property owner's complete name, address, and telephone number.
3. A map with the exact location for all proposed temporary screening points or monitoring well locations for each parcel or property. To ensure the exact parcel is identified, the map should clearly show include the distance from properly identified state or county road intersections.
4. Copies of all previous correspondence to the property owner(s), any reply received from the property owner(s).

This section describes the minimum elements necessary for a Tier II assessment while allowing technical flexibility so that the work may be completed in an effective manner. The purpose of the Tier II assessment is to define the extent of all petroleum CoC (to include RCRA metals for waste oil UST (s) as well as identify all current and potential receptors that could be impacted by the release from a regulated UST system. The results of the Tier II Assessment are to be used to establish appropriate site-specific target levels and recommendations for future actions as outlined in the Risk Based Corrective Action (RBCA) Procedures Section.

1. Tier II Assessment Plan: A concise Tier II assessment plan shall be submitted to the UST Management Division by the tank owner/operator or on their behalf by their site rehabilitation contractor for approval prior to implementation. To assist with preparation of the Tier II Plan, the Freedom of Information Office may be contacted at (803)-898-3882 in order to obtain the technical

file of the release being investigated if previous site data is not available from the tank owner/operator or if information concerning adjacent UST or AST facilities is required. The Tier II plan included as part of the contractors addendum shall include as a minimum:

A. Site information – A summary of all general information including Facility Name, Address, Phone Number, and UST Permit number; the name address, phone number of the UST owner/operator responsible for investigating the release(s); the property owner; the site rehabilitation contractor; and the well driller. If the tank owner/operator responsible for site rehabilitation is different from the current tank owner, include the name, address, and phone number for the current tank owner.

B. Maps - This section must include a copy of the relevant portion of a 7.5-minute United States Geological Survey (USGS) topographic map showing the site location, and a scaled site map. The site map shall conform to industry standards and must include as a minimum: a north arrow, a legend, a bar scale, and the date of data collection. Identify the site by the facility name, complete street address, and UST permit number. The map should indicate the location and identity of all on-site and adjacent structures, existing and/or former UST(s), AST(s) and associated underground piping; identify all streets and/or highways; locate property lines, paved areas, and existing monitoring and other wells (e.g. vapor monitoring wells). All private wells (potable, municipal, irrigation) will be accurately located on the topographic and/or site map.

C. Field Screening Methodology - <u>The use of field screening methods to optimize the number and location of permanent monitoring wells is highly recommended</u>. The selection of field screening methodologies is at the sole discretion of the contractor. The specific field screening methodologies shall be discussed and the proposed location, number and depth of screening points shall be indicated. It is the responsibility of the contractor to ensure the horizontal and vertical extent of petroleum Chemicals of Concern (CoC) are defined prior to installation of monitoring wells

D. Monitoring Wells - The maximum number and depth of monitoring wells, to include soil borings and temporary wells used for screening, estimated to be necessary to define the concentrations and extent of free-phase product and groundwater CoC shall be included in the plan. If the contractor later determines this number to be insufficient, additional monitoring wells or additional footage must be requested of the <u>UST project manager</u>. The well screen length should be a minimum of ten feet for shallow wells and five feet for deep wells. The well screen for shallow wells should be installed so that the water table is bracketed. However, if the contractor is aware of significant groundwater level fluctuations, a longer screen length may be necessary and shall be specified in the plan. A shallow well will typically be installed adjacent to a surface water body that might be impacted. A shallow and deep monitoring well will typically be installed between the release source and all supply wells that could be impacted as a future compliance point for that receptor. Additional wells require the Department's technical approval as well as financial pre-approval if costs are to be reimbursed from the SUPERB Account or will be applied toward a SUPERB deductible. To provide a record of the request by the contractor and approval by the Department, it is recommended that any additions be requested by e-mail to the appropriate UST Project manager.

E. Implementation Schedule – The contractor proposes a schedule indicating the time frame required for submittal of the Tier II report after notification to proceed from the UST Management Division. The due date of the report should be 90 to 100 days from the date of Tier II plan approval unless otherwise designated by the Department. If the work cannot be completed as specified, the UST Project Manager must be notified immediately. A change in the report due date may be issued for work to continue if adequate justification is provided. To provide a record of the request by the contractor and approval by the Department, it is recommended that the appropriate UST Project manager be notified by e-mail.

In some cases, the Department may predetermine a defined scope of work to meet a specific goal(s) (e.g., installation of a compliance well, resample the existing monitoring well network, free product recovery wells, free product recovery test) and plan preparation by the contractor will not be necessary. In these instances, the UST Management Division will notify the tank Owner/Operator and his designated site rehabilitation contractor to proceed with the required work and a due date will be assigned.

Tier II Implementation

1 - Objectives - The objectives and performance standards of the Tier II Implementation are:

A. To delineate the horizontal and vertical extent of CoC in the soil and groundwater,

B. To identify and evaluate all exposure pathways based on a current survey of existing and potential receptors,

C. To characterize the nature of the CoC present,

D. To define the site geology and hydrogeology, and

E. To use fate and transport analysis to predict the actual or potential impact of CoC on receptors if requested by the Department. The Department shall allow some flexibility in meeting this objective, provided that the contractor meets the first four performance standards.

2 - Receptor - Utilities Survey / Site Survey- To successfully complete the receptor and utility surveys the contractor shall:

A. Locate all private and public water supply wells (potable and non-potable) and other potential receptors as defined in the RBCA document (i.e., utilities, surface waters, wetlands, basements) within a 1,000-foot radius of the site or the edge of the plume whichever is farther from the release source. Document the receptor locations in the Assessment Report and depict the locations on the relevant portion of the appropriate United States Geological

Survey 7.5 minute topographic map and on the site base map. Provide a table listing the property owner's name, address, and telephone number for each privately owned receptor.

B. Record the current use (residential, commercial, agricultural, industrial) of the site and adjacent land including all properties having a monitoring well associated with this facility. All adjacent properties with tanks (underground, above ground, or heating oil) that are active or closed will be identified. If the tanks are permitted, the applicable permit number(s) will be provided. Information pertaining to any applicable zoning and land use ordinances shall be obtained from local city or county administrative authorities. Zoning ordinances set broad-scale restrictions on property development such as residential, commercial, or industrial. Land use ordinances may establish smaller scale restrictions such as disallowing the installation of a drinking water or irrigation well. A copy of the applicable sections or a summary of the ordinances shall be provided. Additionally, the name, phone number, and business address of the appropriate local authorities shall be provided with a summary of the relevant information. A photocopy of local regulations or ordinances is not required.

C. If not previously submitted, provide a copy of the applicable portion of the county tax map. This map shall depict the location of the facility, all impacted properties, all properties located adjacent to the impacted properties, and any property on which a monitoring well (to include temporary wells) was installed as part of the investigation. Provide a table listing the names and addresses of the owners of each of these properties and the name of all well(s) on that property or parcel.

D. Locate and report all underground utilities (electrical, natural gas, telephone, water, cable TV, storm drain, and sewer lines) within a 500-foot radius of the site, or 500 feet from the edge of the plume whichever is greater, on a one inch equals 50 foot map unless another scale is approved by the UST Management Division Manager. Depict all identified underground utilities, both on and adjacent to the property, on a scaled site map to the nearest one-foot. The depth (within 2 feet) also shall be reported.

E. If receptors are identified that may be impacted, immediately screen for hydrocarbons using a properly calibrated screening device. Water samples shall be obtained for all drinking water supply wells and surface water bodies within a 1,000-foot radius of the site or within 500 feet of the down gradient edge of the plume. The location of these wells will be included on the site map, and well ownership information will be included in an appendix of the report. If field screening or laboratory analysis indicates the presence of CoC, notify the UST Project Manager within 48 hours of detection at (803) 896-6241 and provide the name, address, and a contact telephone number for all affected property owner(s). All field-screening and laboratory data for sampling of receptors shall be included in the report of findings.

F. The contractor must provide a comprehensive facility survey if not already completed. A South Carolina Licensed Land Surveyor must perform the survey. The scale of the surveyed map should be one inch equals 50 feet unless the UST Project manager previously approved another map scale. The surveyor's certification number, business address, telephone number, and date of survey must be on any applicable maps. The 500-ft by 500-ft foot survey shall include, at a minimum:

1) The locations and relative elevations of potential receptors
2) Existing or former USTs
3) UST lines
4) UST dispensers
5) Field screening points
6) Soil borings
7) Wells (monitoring, vapor wells), and
8) Other above and below ground structures

G. Only one comprehensive survey will be required per Tier II Assessment for surveyed areas up to 250,000 square feet (approximately 500 x 500 feet). If the area was previously surveyed, only a subsequent survey to locate new soil borings, or monitoring wells on the original survey plat will be required.

3 - Soil Boring Installation, Sampling, Analysis, and Abandonment - See Section B1

Site Rehabilitation

Based on the concentration of each CoC and its potential risk to receptors, two processes of Site Rehabilitation are possible: A) active Site Rehabilitation and B) intrinsic remediation or natural attenuation.

1 - Active Site Rehabilitation – This term is synonymous with active remediation and refers to physical actions taken to reduce the concentrations of CoC. Active Site Rehabilitation is applicable where:

A. The concentration of any CoC exceeds the SSTL and must be reduced to prevent an impact to an actual or potential receptor;
B. Free phase product is present with a thickness greater than 0.01 feet or 1/8 inch; or
C. The plume continues to increase in size, CoC continue to migrate away from the source, or the concentration of any individual CoC is increasing.

2 - Intrinsic Remediation or Natural Attenuation - These terms refer to the naturally occurring microbial and fate and transport processes that results in a reduction of the total mass of hydrocarbons. Intrinsic remediation is applicable where:

A. The concentration of any CoC exceeds the RBSL but is less than the SSTL;
B. Measurable free product is not present;
C. The CoC plume is at or approaching equilibrium (i.e., the advancement of the plume is slowing down), and the concentration of a CoC is not increasing at any point;

D. The predicted impact on actual or potential receptors does not exceed the RBSL at any time (i.e., no predicted risk to human health or the environment); and
E. All conditions for intrinsic remediation can be verified in 18 months or less.
F. An intrinsic approach may need to be upgraded to active Site Rehabilitation if the above conditions cannot be demonstrated, a new or potential receptor is identified, or if there is a change in land use or zoning ordinances.

Other UST Work to be implemented

1 - AFVR Events
  A. Aggressive Fluid Vapor Recovery events may be utilized to remove free-phase product from the subsurface.

2 - Public/Private Well Sampling
  A. UST Management Division staff may collect samples from public or private water supply wells in response to a complaint, as part of a receptor survey at a particular site, or as a confirmation sampling to determine current concentrations.

3 - Monitoring Well Sampling
  A. UST Management Division staff may collect samples from monitoring wells to establish or verify current site conditions.
  B. The UST Management Division may direct the responsible party and the certified contractor to conduct a sampling event or may direct the contract certified contractor to conduct a sampling event.

4 - Monitoring Well Installation
  A. The UST Management Division may direct the responsible party and their certified contractor to install monitoring wells or may direct the contract certified contractor to install monitoring wells

5 - Installation of Granulated Activated Carbon (GAC) Units
  A. The UST Management Division may direct the responsible party and their certified contractor to install or may direct the contract certified contractor to install granulated activated carbon units of private supply wells to filter out chemicals of concern until a permanent source of non-impacted drinking water can be obtained.

6 - Abandonment of Monitoring Wells
  A. The UST Management Division may direct the responsible party and their certified contractor to abandon or may direct the contract certified contractor to abandon monitoring wells that are no longer needed or damaged.

The specifics of the above-mentioned work will be detailed in B1

A7 Data Quality Objectives and Data Quality Indicators

Data are evaluated primarily from a standpoint of consistency with the situation, using the expertise and experience gained from past investigations. The Project Manager should evaluate all data for accuracy, validity and defensibility within the context of the overall investigation. For example, data used for field screening to determine the general location of the contaminant plume need not be of the same quality as data used to determine the level of impact to a drinking water source. Hydrogeology, surface topography, the physical location of the site, and the presence of possible receptors are taken into account when evaluating data. The site-specific QAPP Addendum will include a map in Section A7 showing property boundaries and the location of the USTs and possible receptors (both on the property and off). Where appropriate, data verification is employed. Repeat measurements, check samples and "split" samples are all measures that are employed in addition to routine review of laboratory QA/QC to ensure that the data being evaluated is accurate.

The evaluation of data with respect to a site is always performed relative to the history or the future of the particular release, whether preliminary (part of a site assessment or subsurface investigation) or the evaluation of Site Rehabilitation system effectiveness. Data are evaluated, along with previous data, to ascertain the present condition of a site and to project future actions necessary to mitigate the health and environmental impacts of the release. The most important factor in the evaluation of most data (such as groundwater levels and analytical results) is the fact that they are generally a "snapshot in time" for a release. It is important not to attach excessive significance to such data, which may only reflect a short-term fluctuation. Groundwater is a slow-moving medium, and long term monitoring is generally required before definite fate and transport characteristics of a release can be defined. However, employing professional judgment in the evaluation of preliminary data can reduce the investigation period substantially.

The quality of all environmental data generated and processed will be assessed for accuracy, precision, completeness, representativeness and comparability (see Section C1). The data user should ensure that the quality of the data to be used meets the minimum requirements expressed in the study design.

DQO Process:

1. State the Problem: The program is to evaluate the plume of a UST release, and determine the action needed according to regulation.

2. Identify the Decision: If the contamination exceeds regulatory action levels then the action is determined by regulation.

3. Identify inputs to the Decision: Inputs to the decision include the concentrations within the plume.

4. Define the Study Boundaries: The boundaries are laid out in each QAPP addendum (to be developed by the individual contractors).

5. Develop an analytical approach and a Decision Rule: If the contamination is above the RBSLs then the appropriate action is designated in the decision-making flow chart (Appendix A) is done.

6. Specify Limits on Decision Error: Error is inherent in every sampling or analysis procedure. Error is limited by using SCDHEC certified Laboratories. The SC DHEC Office of Environmental Laboratory Certification certifies not only for drinking water parameters, but also for SW846 methodology and CWA methodology. As part of the certification process the Lab's SOPs have been examined by the SCDHEC Office of Environmental Laboratory Certification. Precision, sensitivity, and accuracy, as laid out in those SOPs, are acceptable. The samples are also comparable because the allowed methodology is specified in Appendix E. Representativeness is less important in following a plume of contamination, however, the sampling protocol is stringent enough to ensure that the plume is well defined. Completeness is important to the entire process and contractors are expected to produce a report with at least 90% valid samples/data.

7. Optimize the design for obtaining the data: IGWA, Tier I and Tier II sampling protocols are based on experience with characterizing the leaking UST's plume and impact on receptor wells. Thus these protocols have optimized the design for obtaining the data, making a decision based on accurate information and obtaining outcomes that will protect the human and environmental health through specifying the location of the sampling sites and the number of samples to be collected.

DQIs:

Precision: Precision examines the distribution of the reported values about their mean. The distribution of reported values refers to how different the individual reported values are from the average reported value. Precision may be affected by the natural variation of the matrix or contamination within the matrix, as well as by errors made in the field and/or laboratory handling procedures. Duplicate field and matrix spike/matrix spike duplicate will provide an indication of precision. Precision will be evaluated by the calculation of the Relative Percent Difference (RPD):

$$RPD\ (\%) = \text{Absolute value of } ((C_S - C_D)/(C_S + C_D)/2) \times 100$$

Where: C_S = Concentration of the sample
C_D = Concentration of the duplicate sample

The RPDs will be compared to the limits presented in tables in Appendix E.

Bias: Bias measures the accuracy of a measurement system. Sources of error introduced into the measurement system may be accounted for by using trip blanks and matrix spikes. Error sources are the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analytical techniques. Accuracy will be evaluated by calculating the percent recoveries (%R) of the matrix spike/matrix spike duplicate samples, the laboratory control samples, and the Volatile Organic Contaminate (VOC) surrogates. The %R for the matrix spike samples will be calculated using the following equation:

$$\text{Percent Recovery} = ((C_M - C_S)/T) \times 100$$

Where: C_M = Concentration of matrix spike sample
C_S = Concentration of sample
T = amount spiked

The %R for the laboratory control samples and the surrogates will be calculated using the following equation:

%R = (C/T) x 100

Where: C = observed concentration
T = amount spiked

The percent recoveries will be compared to the limits presented in Appendix E.

Representativeness: Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic of a population, a parameter variation at a sampling point, or an environmental condition. This criterion will be met by assuring that sampling locations are properly selected, that a sufficient number of samples are collected, and that all sampling and handling procedures are conducted in accordance with the protocols outlined in this QAPP.

Completeness: This project is designed based on principles to define the plume of contamination. The number of samples collected and data generated will be reviewed during the project. If some samples become invalid due to collection, shipping, or laboratory problems, the samples may be recollected to ensure that enough data is available to make a sound decision. The number of samples required to define a plume of contamination are dependent on the size of the plume and therefore must be determined in the field during the assessment process. The Project Manager will provide oversight to ensure that the site has been adequately assessed.

Comparability: Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Sample data should be comparable with other measurement data for similar samples and sample conditions. This goal is achieved through using standard techniques to collect and analyze representative samples and reporting analytical results in appropriate units.

Method Sensitivity: Method sensitivity is parameter dependent and is defined in Appendix E.

A8 Training and Certification

All SCDHEC UST Management Division staff involved in the assessment and remediation process working on UST projects must have the following training:

- 40-hour OSHA HAZWOPER

- OSHA HAZWOPER Annual Refresher

Most personnel with QA responsibilities within the UST Management Division have acquired their QA experience through on-the-job training. Those designated to serve in the program have a technical (scientific, engineering) background that includes previous experience with QA concepts and with evaluation of data generated from environmental measurements. Management within the UST Management Division encourages and supports the acquisition by personnel of quality assurance experience or pertinent experience and information. This is done through:

- participation in QA-related EPA seminars;
- attendance at appropriate professional meetings, conferences or workshops;
- enrollment in appropriate short courses.

It shall be the policy of the Department to provide resources to allow for personnel involved in leaking UST investigations to receive training relating to groundwater contamination, Site Rehabilitation technologies, and health and safety issues. Records of all the training classes taken by the UST Management Division staff are kept in each staff member's personnel file.

UST Management Division staff will undergo all necessary training to ensure compliance with the EQC SOP Manual regarding field procedures (acceptable sampling techniques, sample collection, preservation and handling procedures, and field instrument operation and documentation procedures).

Contractor requirements:

In accordance with Section IV.A.4 of the SUPERB Site Rehabilitation and Fund Access Regulations, R.61-98, a Class I certified contractor must have at least one full-time permanent employee of that company registered as a Professional Engineer or Geologist in South Carolina and have at least three years applicable experience in performing site rehabilitation activities related to releases of regulated substances from underground storage tanks. The certification number must be provided on all reports submitted to the UST Management Division.

A Class II certified contractor must have a minimum of three years applicable experience in performing site rehabilitation activities related to releases of regulated substances from underground storage tanks; and any necessary South Carolina certification and/or license. The certification number must be provided on all reports submitted to the UST Management Division.

All site rehabilitation activities at LUST sites must be conducted by a SC DHEC certified site rehabilitation contractor as required by SUPERB.

The contractor must ensure that personnel working on UST projects receive the necessary training to collect samples at UST sites, which is to include a minimum of 40-hour OSHA HAZWOPER and OSHA annual refresher and training in sampling protocols and procedures.

Well drillers must be certified in accordance with Title 40, Chapter 23 of the SC Code of Laws. The certification number must be provided on all well forms submitted to the UST Management Division. The certification number must also be provided in the site-specific QAPP addendum.

Laboratories must be certified in accordance with SCDHEC Office of Laboratory Certification for the analytical methods performed. The laboratory certification number must be provided on all laboratory data submitted to the UST Management Division. The certification number must also be provided in the site-specific QAPP addendum.

All of the above information will be obtained from the contractor as part of their addendum to the QAPP. In addition the contractor must specify who will be responsible for detailing how training will be provided, who will be responsible for assuring that personnel participating in the study receive proper training, and where the training is documented.

A9 Documents and Records

The UST Management Division QAPP will be reviewed and, if necessary, revised at least annually by the UST Management Division QAPP Manager. Any required updates to the QAPP will be distributed in accordance with the distribution list contained in this document. A copy of the QAPP will be maintained in a common directory on the UST Management Division file server. The UST project managers will be required to sign a statement indicating that they have received a copy of the QAPP. A new form must be signed whenever revisions to the QAPP are made to ensure that all project managers have been provided the most recent version of the QAPP. UST Certified Contractors will be provided a copy of the QAPP electronically. The contractor will be required to sign a statement indicating receipt of the QAPP. The statement will be required as part of the yearly certification renewal process. A new form will be required to be submitted when revisions to the QAPP are made. The contractor's addendum will include a signature page signed by all parties involved in the project that they have received the most recent version of the Program QAPP and the site-specific QAPP.

All records and reports submitted to the UST Management Division that contain interpretation of the data provided must be signed and sealed by a Professional Engineer or a Professional Geologist registered in the State of South Carolina. All original records and reports submitted to the UST Management Division must be maintained by the contractor for a minimum of 5 years, unless otherwise specified by the UST Management Division. Record archival policies for SC DHEC UST are given in Appendix_J. This includes electronic as well as hard copy storage.

Each report submitted to the department shall include, at a minimum, the following elements as applicable to the scope of work being conducted:

A. Introduction:
   1. UST Facility Name, Permit #, Address, Phone Number, UST Owner's and Operator's name, address, and phone number
   2. Name, address, and telephone number of the property owner
   3. DHEC Certified UST Site Rehabilitation Contractor's Name, Address, telephone number, and certification number

4. Name, address, telephone number, and certification number of the well driller that installed borings/monitoring wells.
5. Name, address, telephone number, and certification number of the certified laboratory performing analytical analyses.
6. Facility history including tank information (number, size, and contents of all current and former USTs), date release reported to DHEC, estimated quantity of release, cause of release (if known), and status of any other releases at the facility. If the facility is no longer a petroleum marketing facility, please provide the current facility name and use. If the facility is currently not in use, please list the current use as vacant.
7. Regional geology and hydrogeology.

B. Receptor Survey & Site Data

1. Receptor survey results- Locate all private and public water supply wells (drinking and non-drinking) and other potential receptors (as defined in the South Carolina Risk Based Corrective Action (RBCA) Guidance Document, i.e., utilities, surface waters, wetlands, basements) within a 1,000-foot radius of the site. - the results shall include all known groundwater quality and public and private groundwater usage
2. Document the current use of the site and adjacent land (residential, commercial, agricultural, industrial, etc.). Identify any UST site(s) within a 1000-foot radius of the subject site and provide their UST permit number(s) in the report.
3. Site-specific geology and hydrogeology

C. Soil Assessment/Field Screening Information & Methodology

1. Describe the primary soil type and field screening results.
2. Describe how the soil sample was collected (e.g. two encore samplers and one four ounce jar) and preserved.
3. Describe how the field screening was conducted.

D. Monitoring Well Information

1. Provide the monitoring well installation and development date(s).
2. Describe the well development procedure.
3. Provide justification for monitoring well locations.

E. Groundwater Data

1. Describe the groundwater sampling methodology and provide the date sampled. Include groundwater measurements (temperature, pH, dissolved oxygen, specific conductance.)
2. Describe the purging methodology and provide the volume of water purged and groundwater measurements to verify that purging is complete.
3. If free product is present, provide the thickness.

F. AFVR Information

1. A brief description of the completed work scope and any relevant descriptions pertaining to the data tables.
2. A table summarizing the airflow (in CPM) and volatile concentrations collected from the stack of the truck every thirty minutes through the duration of the event. The table shall

also document which well(s) were being recovered from during that time interval.

3. A table summarizing the magnehelic gauge measurements from all applicable wells on a thirty-minute time interval.
4. The total volume of water recovered (gallons).
5. The total volume of free phase product recovered (typically measured with a product/water interface device inserted into the top of the tanker at the completion of the event and then converted to an approximate volume).
6. The total mass of petroleum removed as vapor. This is calculated based on the airflow rate and the concentration of vapor.
7. A table documenting the free product thickness in each well before and after the recovery event.
8. Scaled base map depicting the location of the extraction wells and the surrounding wells equipped with magnehelic gauges.
9. Recovered free phase petroleum and groundwater must be accepted by a permitted treatment facility. There can be no spillage or leakage in transport. A copy of the disposal manifest from the receiving facility that clearly designates the quantity received must be included as Appendix G in the final report.

G. Granulated Activated Carbon Installation

1. Description of the unit installed, to include carbon capacity, warranty information, counter information, validation by Water Quality Association, where installed, combination or key information, etc.
2. A schematic diagram of the unit (new or old) with the model number, serial number, site name, UST permit number, inlet and outlet ports will be required. This information must be submitted within one week of installation.
3. The contractor must provide all calculations for determining COC breakthrough and the frequency at which the filter material must be changed.
4. All work under this contract must be done by a professional plumber certified in the State of South Carolina. Proof of certification must be provided with the QAPP Addendum

H. Results & Discussion

1. Assessment results – the report shall include a brief discussion of the assessment and results. The discussion shall include all methodology used.
2. Aquifer evaluation results (if conducted) – the report shall include a brief discussion of the aquifer evaluation and results.
3. Fate & transport results (if conducted) – the report shall include a brief description of the fate & transport model(s) used. All assumptions shall be clearly identified. The input parameters are to be given in tabular format. The method of model calibration for each CoC shall be discussed.
4. Tier 1 Risk Evaluation
   i. Site Conceptual Model Tables must be included. (See Appendix D)
5. Tier 2 Risk Evaluation (If requested by the UST Project Manager)
   i. Exposure pathway analysis. It is recommended that the site rehabilitation contractor fax all screening data, receptor locations, exposure points, and compliance points to the project manager at (803) 896-6245 prior to the start of

exposure modeling. The tier analysis shall be done in accordance with the Risk Based Corrective Action (RBCA) Procedures Section.

ii. SSTLs shall be calculated for each CoC and for each potential vapor, soil, and groundwater exposure pathway. Results shall be tabulated.

iii. Recommendations - The report shall include recommendations for further action (Tier III assessment, active remediation, intrinsic remediation, etc.) as warranted by the Tier 2 evaluation.

I. Tables

1. Soil Analytical data for the site shall be given in tabular form as Table 1. Soil borings should be designated with the 5-digit permit and boring id (e.g. 12345-SB1) on the chain of custody forms.
2. Potentiometric data for the site shall be listed in tabular form for this and all previous sampling events as Table 2. This should include top of casing elevations, screened intervals, depth to water, depth to product, and groundwater elevation for each well.
3. Laboratory data shall be summarized in a tabular form and must include current and historical data. Monitoring wells should be designated with the 5-digit permit number and the well id (e.g. 12345-MW1) on the chain of custody forms. Water supply wells should be designated with the 5-digit permit number and the well Id (e.g. 12345-WSW1). Surface water sampling locations should be designated with the 5-digit permit number and the location ID (e.g. 12345-SW1). Include groundwater measurements (temperature, pH, dissolved oxygen, specific conductance.)
4. Aquifer characteristics – hydraulic conductivity, seepage velocity, etc. shall be summarized on the appropriate DHEC form.
5. Site Conceptual Model - identify the data necessary to characterize the migration potential along the pathway and to quantify the potential impact.

J. Figures

1. Topographic Map- the report shall include a copy of the relevant portion of a USGS topographic map showing the site location and the locations of all public and private water supply wells and other potential receptors within 1,000 feet of the site or the down-gradient edge of the plume whichever is greater. The figure will be captioned with the facility name and address, UST Permit number, date, and bar scale. The map must include a north arrow. Label as Figure 1.

2. Site base map-
   i. Initial Groundwater Assessment: The site base map, labeled as Figure 2, shall be accurately scaled, but does not need to be surveyed. The map shall include the following:
      1. Legend including the facility name and address, UST Permit number and a bar scale.
      2. North arrow.
      3. Location of property lines.
      4. Streets or highways (indicate names and numbers).
      5. Location of buildings.
      6. Paved areas on or adjacent to site.

7. Location of all present and former above ground and underground storage tanks and associated lines, pumps, and dispensers.
8. Underground and aboveground utilities on or adjacent to site (sewer, water, telephone, gas, electric, etc.).
9. Location of any potential receptors.
10. Previous soil sampling locations.
11. Boring/Monitoring well location.

ii. Tier I Assessment: A scaled location map indicating the location of the site and any receptors within a 500-foot radius of the facility. The figure will be captioned with the facility name and address, UST Permit number, data, and bar scale. The map must include a north arrow. Label the map as Figure 2

iii. Tier II Assessment: a surveyed map (scaled to one inch equals fifty feet) that shows structures, underground utilities, potential receptors, USTs and associated piping and dispensers, and the locations of all sampling points and monitoring wells for a minimum distance of 500 by 500 feet with the UST facility in the center of the map. The figure will be captioned with the facility name and address, UST Permit number, data, and bar scale. The map must include a north arrow. Label the map as Figure 2

3. CoC site maps - the maps shall show the known and estimated horizontal extent of CoC in the soil and groundwater. Analytical values for the CoC shall be indicated at each sampling point. A separate map shall be used for each medium. Label the Soil CoC map as Figure 3 and the Groundwater CoC map as Figure 4. If the groundwater investigation involves multiple aquifers or depth intervals, each aquifer or depth interval shall be depicted on a separate map (e.g. Figure 4a - Groundwater CoC-Water Table, Figure 4b - Groundwater CoC- Confined, etc.)

The analytical data should be adjacent to the relative sampling point and should use the following format (additional parameters such as dissolved oxygen may be required):

	EDB (µg/l)
Sample ID (MW# or SB#)	1,2 DCA (µg/l)
Benzene (µg/kg or µg/l)	ETBE (µg/l)
Toluene (µg/kg or µg/l)	3,3-Dimethyl-1-butanol (µg/l)
Ethylbenzene (µg/kg or µg/l)	TAME (µg/l)
Xylenes (µg/kg or µg/l)	DIPE (µg/l)
Naphthalene (µg/kg or µg/l)	TBF (µg/l)
PAHs (µg/kg or µg/l)	TBA (µg/l)
Total Lead (µg/kg or µg/l)	TAA(µg/l)
RCRA Metals (µg/kg or µg/l)	

Note: Not all parameters apply. If the laboratory analysis indicates <u>all</u> CoC at or below detection limits "ND" may be listed on the map beside that boring or monitoring well.

4. Site potentiometric map - the map shall indicate the water level elevations for each monitoring well and show the direction of groundwater flow for the surficial aquifer. (Tier I, Tier II, groundwater sampling events). Label as Figure 5 NOTE: Great care should be

exercised in the use of computer contouring programs (e.g., Surfer®). Any unusual potentiometric features depicted on the map (e.g., sinks, mounds, abnormally steep gradients, etc.) must be explained.

5. Geologic cross-sections - the report shall include two cross-sections showing the lithology and stratigraphy of the site, and the known and estimated vertical extent of CoC in the soil and groundwater. The cross-sections shall intersect at a 90-degree angle if possible. One cross-section shall include the source area and go down-gradient through as many wells as practicable with the highest concentrations. If a subsequent assessment is conducted to define the extent of CoC, the cross-sections will be updated to include the additional wells. (Tier II). Label as Figure 6.
6. A map or series of maps showing the predicted migration and attenuation of the CoC through time shall be presented. Total BTEX and TPH maps will not be used. (Tier II)

K. Appendices

1. Appendix A: Site Survey prepared and certified by a South Carolina Licensed Professional Land Surveyor (Tier I and Tier II) The surveyed base map should be plotted to an accuracy of 1-foot and include the following:
    i. Location of property lines, for the subject site and all affected adjacent properties
    ii. Streets and highways (indicate names)
    iii. Location of buildings
    iv. Paved areas on or adjacent to site
    v. Location of present and former above ground and underground storage tanks and associated lines, pumps, and dispensers.
    vi. Underground utilities on or adjacent to the site (sewer, water, gas, telephone, electric, etc.)
    vii. Location of any potential receptors
    viii. Soil boring locations
    ix. Monitoring well locations
    x. Survey datum location
    xi. Captioned with the facility name and address, UST Permit number, date, and bar scale.
    xii. North arrow
2. Appendix B: Sampling logs, laboratory data sheets and chain-of-custody forms. The analytical data packages will include the following information: sample results with units, method blank results, laboratory control sample recovery, matrix spike/matrix spike duplicate recoveries and relative percent differences, date and time of sample collection, date and time of sample receipt, date and time of sample extraction/preparation, date and time of sample analysis, dilution factors, pH of water samples, sample temperature at time of receipt, analytical methods used, method detection and quantification limits, problems and Site Rehabilitations, and applicable certifications. In addition, a laboratory data package must be included that should include raw data/instrument printouts, calibration data (initial and continuing), method and preparation blanks, field blanks, QA/QC data, digestion/extraction bench sheets, analytical logs, etc.
3. Appendix C: A copy of the relevant portion of the tax map depicting the location of the facility, all impacted properties, and all properties located adjacent to the impacted

properties shall also be included. The property owner names, addresses, and phone numbers as well as a list of monitoring wells installed on each parcel should be included in tabular format. The report shall also include a scaled site vicinity map that indicates site location, surface drainage, structures, roads, receptors, and adjacent property uses. (Maps should not be integrated in the report.) List of adjacent property owner and well owners with their information.

4. Appendix D: Soil Boring/Field Screening logs for Temporary Wells and Screening Points to include DHEC Form 1903 for any abandoned temporary borings or wells.
5. Appendix E: Well completion logs and SCDHEC Form 1903 for all well(s);
6. Appendix F: Aquifer evaluation summary forms, data, graphs, equations
7. Appendix G: Disposal manifests
8. Appendix H: Local zoning regulations
9. Appendix I: If requested by the UST Management Division Manager, all fate and transport modeling assumptions, data input to each model, and all generated output data.
10. Appendix J: Copies of any access agreements obtained by the contractor to complete the required work.
11. Appendix K: Data verification checklist

SECTION B – DATA GENERATION AND ACQUISITION

B1 Sampling Process Design/Experimental Design

Each sampling process is described below. Since all information is potentially critical in nature, any problems with sample collection or access to the sites must be reported to the SC DHEC UST Project manager to determine what actions should be taken (resampling, etc.) Variability is expected in these samples due to nature of sampling for contamination. The project manager is also to be contacted when anomalies are found in the data or in the site itself.

IGWA Sampling Process Design:

1. Receptors
   A. Immediately upon locating any receptors screen them for hydrocarbons using a properly calibrated screening device. The Contractor's Addendum shall state what screening device will be used, along with the information required in Section B concerning calibration, maintenance and inspection.
   B. Obtain water samples for all water supply wells and surface water bodies within a 250-foot radius of the site. All municipal supply wells within a 1000-foot radius shall also have a sample collected and analyzed for the appropriate parameters (See Table 6)
   C. Notify the UST project manager at (803)-896-6241 as soon as possible if any water samples are collected.
   D. If field screening indicates the presence of hydrocarbons notify the UST project manager at (803)-896-6241 as soon as possible within 48 hours of detection and provide the name, address and a

contact telephone number for all affected property owners. All field-screening and laboratory data for these receptors shall be included in the Report of Findings.

2. Monitoring Well or Boring Installation
    A. One permanent monitoring well constructed of 2 inch diameter PVC casing with a 10 foot length of PVC screen bracketing the water table shall be installed in the area showing the highest concentration of the compounds of concern above risk based screening levels as documented from the previous soil and/or groundwater assessment. (Alternatively, the Department may specify a location.)
        i. The well shall be installed under the direction of a SC Certified Well driller and in compliance with the SC Well Standards and Regulations, R. 61-71.
        ii. The well shall require proper filter pack, grout, locking well cap, well pad at or above the land surface, data plate and a cover held in place with bolts or screws.
        iii. Any wells installed in traffic areas must be flush-mounted. All other wells should be completed with a 1-foot minimum stick-up casing.
        iv. The well must be properly developed so that the method used to develop it is capable of removing enough formation cuttings, drilling fluids, and additives to provide relatively sediment-free water samples that are typical of the aquifer.
    B. During well installation, soil samples are to be collected for screening at five-foot intervals.
        a. The Soil Lithology shall be documented on a drilling log. The following should be noted:
            1. Color, using standard methods
            2. soil type
            3. rocks or minerals present,
            4. split-spoon sample intervals
            5. any organic vapor and field measurements
            6. qualitative indication of soil conditions (dry, moist, water saturated and any staining of the soil by waste oil).
            7. The drilling log should also note the depth of each sample submitted for analysis.

        b. Enclose the boring log, DHEC Form 1903, and Water Well Record as attachments to the Report of Findings.
        c. If groundwater is encountered within 25 feet of the surface, a monitoring well shall be installed. Additional footage up to 50 feet is allowed upon approval of the project manager.
        d. With every monitoring well, a soil sample is also collected and analyzed for the appropriate parameters (see Table 6) using field-screening devices. The soil sample with the highest screening values (above the water table) is collected for lab analysis. If the soil samples are within 10% of each other the sample from the greatest depth is the one selected for lab analysis.
        e. If groundwater is not encountered within 50 feet of the surface, the soil sample with the highest field screening value shall be collected for analysis.
    C. Groundwater samples shall be collected after the well has been developed and allow to equilibrate for at least 24 hours or until the groundwater returns to the pre-drilling conditions.

a. Report the thickness of any free phase product as follows:

1. Record the distance from the top of the casing to the top of the free product.
2. Record the distance from the top of the casing to the product/water interface.
3. Subtract #1 from #2 to get the thickness of the free product.
4. If the free product exceeds 1/8 of an inch then the collection of a ground water sample is not necessary.
5. If no free product is encountered, the well shall be properly purged prior to sampling and the pH, temperature, DO, and specific conductance are reported.

D. Analyze soil and groundwater for the following parameters:

Groundwater	Soil
Benzene Toluene Ethylbenzene Xylenes Naphthalene Methyl tertiary butyl ether (MTBE) Polynuclear Aromatic Hydrocarbons (PAHs) Dissolved lead Ethylene Dibromide (EDB) 1,2-DCA	Benzene Toluene Ethylbenzene Xylenes Naphthalene Methyl tertiary butyl ether (MTBE) Polynuclear aromatic hydrocarbons (PAHs) Total lead
Waste Oil Groundwater	**Waste Oil Soil**
Benzene Toluene Ethylbenzene Xylenes Naphthalene Methyl tertiary butyl ether (MTBE) Polynuclear aromatic hydrocarbons (PAHs) Dissolved lead Ethylene Dibromide (EDB) 1,2-DCA 8 RCRA Metals, as total metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver)	Benzene Toluene Ethylbenzene Xylenes Naphthalene Methyl tertiary butyl ether (MTBE) Polynuclear aromatic hydrocarbons (PAHs) 8 RCRA Metals, as total metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver)

Table 6 Required Sampling Parameters

E. Designation

i. Monitoring well is to be designated with the 5-digit permit number and the well identification number (e.g. 12345-MW1).

ii. Water supply wells are to be designated with the 5-digit permit number and the well identification number (e.g. 12345-WSW1).
iii. Surface water sampling locations are to be designated with the 5-digit permit number and the location identification number (e.g. 12345-SW1).

Tier I Sampling Process Design

1. Receptors:
   A. If receptors are identified that may be impacted, they shall be immediately screened for hydrocarbons using a properly calibrated organic vapor analyzer or other similar screening device.
      i. If field screening indicates the presence of hydrocarbons, notify the UST project manager as soon as possible within 48 hours of detection at (803)-896-6241 and provide the name, address, and a contact telephone number for all associated property owners.
   B. Water samples shall be obtained for all water supply wells within a 500-foot radius of the site.
   C. All field-screening and lab data for these receptors shall be included in the Tier 1 Report.
2. Soil Boring Installation, Sampling, and Analysis
   A. Install eight soil borings in the locations described below:
      i. UST Area-either adjacent to currently operating USTs or in the area formerly occupied by USTs:
         1. Two soil borings are installed to a depth of 25 feet or to the groundwater table, whichever is shallower.
         2. Soil samples shall be collected at five-foot intervals to the boring terminus; however, do not collect soil samples below the water table.
      ii. Piping and Dispenser Area:
         1. Install five borings to a depth of ten feet or to the groundwater table, whichever is shallower, in the areas formerly occupied by the lines and product dispensers or adjacent to currently operating lines and dispensers.
         2. Soil samples shall be collected at two-foot intervals to the boring terminus, however do not collect soil samples below the water table.
      iii. Background Soil Boring
         1. One soil boring is to be installed at least 30 feet away from any USTs product lines, dispensers, and other potential sources of chemicals of concern. This boring is drilled to a depth of 10 feet or to the groundwater table, whichever is shallower.
            a. If the site is too small to allow a 30 foot separation, install this soil boring as far away from all USTs, product lines, dispensers, and other sources of contamination as possible.
         2. A soil sample is collected from below the "A" horizon, unless precluded by a shallow water table. Do not collect soil samples below the water table.
   B. The lithology of each collected soil sample is described and also screened for organic vapors.
      i. The method of field screening to be utilized is at the discretion of the contractor and shall be included in the Contractor's Addendum to this QAPP or the SOP shall be attached to

the Addendum. Any technology that accomplishes Tier I Assessment performance standards and meets all regulatory requirements is acceptable.

ii. A separate Geologist log should be used for each boring. These should be included as the appropriate appendix to the report. In this log record:

3. Soil type
4. Color of the soil using standard methods
5. Rocks or minerals present
6. Split-spoon sample intervals
7. Field screening measurements
8. Qualitative indication of soil conditions (dry, moist, saturated)
9. Depth of each sample submitted for analysis.
10. Name and signature of the person collecting the data.
11. Location, depth and type of each sample submitted for analysis (see the next section).

C. The following shall be submitted for analysis to a SC DHEC Certified Laboratory:

i. One soil sample from each boring around the USTs, piping and dispensers shall be submitted to a SCDHEC certified laboratory for analysis for the following compounds: Benzene, Toluene, Ethylbenzene, Xylenes, Naphthalene, Methyl tertiary butyl ether (MTBE), Polynuclear Aromatic Hydrocarbons (PAHs), and total lead. Samples from sites with a waste oil release shall also be analyzed for the 8 RCRA metals (lead, mercury, arsenic, barium, cadmium, chromium, selenium, and silver). Refer to Appendix F for collection and preservation methods.

ii. Two additional soil samples form the soil boring with the sample exhibiting the highest field-screening results will be submitted for the following analyses:

1. One sample for grain size/hydrometer analysis to determine the sand, silt, and clay fractions at 0.074 mm (#200 screen) and at 0.004 mm, respectively.
2. One sample shall be analyzed for total petroleum hydrocarbons using EPA method 8015C (DRO).

iii. The soil sample collected from the background soil boring shall be analyzed for total organic carbon. TOC must be performed using a TOC analyzer equipped with a soil sample attachment.

3. Monitoring Well Installation, Sampling, and Analysis

A. A total of three 2-inch PVC-casing wells, with 10-foot screens bracketing the water table shall be installed and constructed in compliance with the SC Well Standards, R. 61-71. Each well shall require proper filter pack, grout, locking well cap, well pad at or above the land surface, data plate, and a cover held in place with bolts or screws.

B. Locations

i. The first monitoring well shall be installed in the immediate location of the soil boring that exhibited the highest field-screening concentration.

ii. The second monitoring well shall be installed in the location of the background soil boring.

iii. The third monitoring well shall be installed in a position on the site so that the direction of groundwater flow can be determined. This well may not be constructed in a location of a previous boring.

C. Designation:
   i. Monitoring wells shall be designated with the 5-digit permit number and the well identification number (e.g. 12345-MW1).
   ii. Water supply wells should be designated with the 5-digit permit number and the well identification number (e.g. 12345-WSW1).
   iii. Surface water sampling locations should be designated with the 5-digit permit number and the location identification number (e.g. 12345-SW1).
   iv. Monitoring wells are to be numbered consecutively in order of installation.

D. Soil Sample Collection
   i. During well installation, soil samples are to be collected for screening at 5-foot intervals using a split-spoon or other discrete-interval, sampler. Samples collected from auger cuttings are <u>not</u> acceptable.
      1. The soil lithology of each sample is recorded on a Geologist's log with all the information previously described.
      2. The soil sample exhibiting the highest concentration of the chemicals of concern from each borehole shall be submitted for laboratory analysis as given in Table 3 unless
      3. All screening levels for all the samples are within 10%, then the deepest sample (ABOVE THE VADOSE ZONE) shall be submitted for analysis.

E. After well installation
   i. Wells must be properly developed in compliance with Regulation R.61-71. The method of development is at the discretion of the contractor and should be described in the Contractor's Addendum. Development is considered complete once enough solids, mud, and fluids have been removed so that the groundwater samples are typical of the shallow aquifer and relatively sediment free.
   ii. Survey the elevation of the Top of Well Casing for each well relative to an established datum on site. The datum shall be identified in the Report and its location marked on the site map.
   iii. The static water level shall be measured after the well has been developed and allowed to equilibrate for a minimum of 6 hours.
      1. If free product is present, the thickness shall be measured and recorded. The distance from the Top of Well Casing to the free product shall be measure to the nearest 0.01 foot and recorded.
      2. The collection of a groundwater sample is not necessary if free product in the well exceeds 0.01 foot (1/8 inch).
   iv. Groundwater samples
      1. Should only be collected after the wells have equilibrated for at least 24 hours after development.
      2. Well shall be purged prior to sampling.
         a. During purging, indicator parameters of pH, temperature, DO, and specific conductance shall be monitored and recorded.
         b. Purging is considered complete once the groundwater temperature and pH measurements have equilibrated.
         c. Field data sheets documenting purging volumes and measure parameters shall be included as a report attachment.

d. Groundwater samples must be analyzed for the following parameters: Benzene, Toluene, Ethylbenzene, Xylenes, Naphthalene, Methyl tertiary butyl ether (MTBE), Polynuclear Aromatic Hydrocarbons (PAHs), total and dissolved lead, Ethylene Dibromide (EDB), 1,2-DCA. Samples from sites with a waste oil release shall also be analyzed for the 8 RCRA metals (lead, mercury, arsenic, barium, cadmium, chromium, selenium, and silver).

4. Aquifer Evaluation:
   a. Two separate aquifer slug tests shall be completed from different monitoring wells located outside of the UST area to determine aquifer characteristics.
   b. Data shall be collected, evaluated, and analyzed in accordance with industry standards (Hvorslev, Bower and Rice, etc.). The slug test shall be reported in the format as shown at www.scdhec.gov/eqc/lwm/forms/slugtest.pdf. The completed forms shall be attached to the report in the appropriate appendix (See Section A9).

Tier II Implementation

Soil Boring Installation, Sampling, and Analysis:

If not previously defined and quantified, the horizontal and vertical extent of impacted vadose zone soil contamination shall be fully delineated according to the following:

1. Install soil borings as follows:

A. UST Area: Install soil borings to a depth of 25 feet or to the groundwater table, whichever is shallower, in the area formerly occupied by the USTs or adjacent to the currently operating USTs. Soil samples shall be collected at the surface and at five-foot intervals to the boring terminus. DO NOT COLLECT SOIL SAMPLES BELOW THE WATER TABLE.

B. Piping and Dispenser Area: Install borings to a depth of ten feet or to the groundwater table, whichever is shallower, in the area formerly occupied by the lines and product dispensers or adjacent to the currently operating product lines and dispensers. Soil samples shall be collected at the surface and at two-foot intervals to the boring terminus. DO NOT COLLECT SOIL SAMPLES BELOW THE WATER TABLE.

C. Background Soil Boring: Install one soil boring to a depth of 10 feet or to the groundwater table, whichever is shallower, at least thirty feet away from any USTs, product lines, dispensers, and other potential sources of CoC. If the site is too small to allow a separation of thirty feet, install this soil boring as far away from all USTs, product lines, dispensers, and other potential sources of CoC as possible. Collect a soil sample from below the A horizon unless precluded by a shallow water table. DO NOT COLLECT SOIL SAMPLE BELOW THE WATER TABLE.

D. If the Extent of Soil Contamination is not defined by the borings described above, continue moving away from the area of contamination and installing borings to a depth of ten feet or to the groundwater table, whichever is shallower until the extent of soil contamination is defined. Soil samples shall be collected at the surface and at two-foot intervals to the boring terminus. DO NOT COLLECT SOIL SAMPLES BELOW THE WATER TABLE.

2. Soil Sample Descriptions:

A. Describe the lithology for each soil sample collected during boring installation. Screen for organic vapors utilizing properly calibrated instruments (for other less volatile chemicals such as diesel or kerosene, alternative screening methods such as Field Gas Chromatograph, or immunoassay shall be used).

B. On a separate log for each boring, record the soil type, color of soil using standard methods, rocks or minerals present, split-spoon sample intervals, and any organic vapor and field screening measurements. Additionally, a qualitative indication of soil conditions (dry, moist, wet, saturated) shall be noted on the logs. The boring logs shall note the depth of each sample submitted for analysis.

3. Requirements for the sample with the highest organic vapor measurement and the background sample:

A. If not previously conducted, the soil sample from each boring around the USTs, piping, dispensers, or other area with the highest organic vapor measurement shall be submitted to a Department certified laboratory for analysis of benzene, toluene, ethylbenzene, and xylenes (BTEX), naphthalene, PAHs, and lead. Samples from sites with a waste oil release shall also be analyzed for the 8 RCRA metals (lead, mercury, arsenic, barium, cadmium, chromium, selenium, and silver). All industry standard quality assurance and quality control methods shall be followed for sample collection and shipping (sample labels, sealed sample containers, completed chain of custody forms, shipment to the laboratory on ice). Refer to Appendix F for collection and preservation methods and Appendix E for analytical parameters and other requirements.

B. In addition to the samples described above, if not previously conducted, the one soil sample collected from the boring that exhibited the highest organic vapor measurement (not from a background boring) shall be forwarded to a certified laboratory for a grain size/hydrometer analysis to determine the sand, silt and clay fractions at 0.074 millimeters (#200 screen) and 0.004 millimeters respectively. A second soil sample shall be collected from above the groundwater table and analyzed for Total Petroleum Hydrocarbons (TPH) using Environmental Protection Agency (EPA) method 8015C (DRO). Additional soil samples above or below the water table may be submitted to a certified laboratory for grain/sieve analysis, TPH or TOC; however, the Department must pre-approve these samples.

C. In addition, a soil sample collected from the background soil boring shall be analyzed for total organic carbon (TOC). TOC must be performed using a TOC analyzer equipped with a soil sample attachment.

If the collection location, collection methods, laboratory methods, and/or detection limits for soil or groundwater are not below the risk-based screening levels (RBSL) as outlined in Appendix C, the Department cannot consider a closure or no further action decision.

4. Soil Boring Abandonment - All soil borings and screening points shall be properly abandoned with neat cement grout as regulated by the South Carolina Department of Labor, Licensing, and Regulation and in compliance with the South Carolina Well Standards and Regulations R.61-71, Section I.3.

5. Soil Leachability Model - If requested by the Department and not previously calculated, calculate the site-specific target levels (SSTLs) for each CoC in the soil. The Soil Leachability Model provided in the RBCA document shall be utilized unless an equivalent method is approved. Model input parameters and results shall be recorded on the appropriate forms found in the RBCA document. The calculated groundwater SSTLs shall be used to calculate soil SSTL values. If groundwater is less than 5 feet below ground surface (bgs), the Soil Leachability Model is not required.

6. Field Screening - The contractor shall propose in the Tier II Assessment plan appropriate sample collection methodology and field screening techniques based on the anticipated CoC. The method for sample collection and the field screening technique shall be at the discretion of the contractor. The objective of field screening is to adequately delineate the horizontal and vertical extent of any free phase petroleum and petroleum constituents in soil and groundwater and to use the field screening results to optimally locate the monitoring wells. Field screening locations, field sampling results, and proposed monitoring well locations must be provided to the DHEC project manager for concurrence prior to the installation of permanent wells. It is the responsibility of the contractor to ensure the horizontal and vertical extent of petroleum CoC are defined prior to installation of monitoring wells. Shallow screening should concentrate on defining the edges of the plume laterally (to include up gradient of the source), between the source and receptors (wells, surface waters, and utilities) to determine if a preferential pathway exists, and define strata with high hydraulic conductivity (sand stringers, gravel beds). The contractor or their subcontractors shall not access private property, roads shall not be cleared, nor vegetation cut without the property owner's written consent. A copy of all agreements obtained from adjacent property owners should be included in the final report as the appropriate appendix.

A. Methods -Typical methods of screening include one or a combination of the following:

i. Screening using an on-site semi-quantitative analytical method(s) that is capable of detecting benzene, naphthalene, MtBE and EDB without sending screening samples to a certified laboratory. The method(s) will be capable of providing real-time on-site data; i.e. the data is obtained as borings are advanced or within 30 minutes of sample collection. Typical instrumentation includes, but is not limited to, field gas chromatography and/or other methods that would provide detection limits at or below the RBSL for benzene, naphthalene, MtBE and EDB as a minimum. The method(s) used and the results will be submitted to the appropriate project manager for concurrence with proposed well locations before monitoring wells are installed and included in the report.

ii. Screening by submitting selected vertical and down-gradient groundwater samples to a certified laboratory for analysis. To be considered defined; the laboratory analysis should provide results at or below the RBSL for each CoC. The screening and laboratory results will be submitted to the appropriate project manager for concurrence before monitoring wells are installed and included in the report.

iii. Fractured Rock screening using methods to identify individual fractures or zones containing a series of fractures. Fractures may be identified by use of calipers, gamma logs, temperature sensors, flow sensors, video cameras or other in-bore methods and techniques. The goal will be to locate all fractures 0.01 foot or larger, the orientation of the fracture(s) in an individual boring, and collating fractures over the entire site if multiple wells or borings are logged at the site as well as the reporting of this data. The method(s) used and the results will be submitted to the appropriate project manager to determine screen locations in the core hole or if the core hole should be abandoned.

B. Procedures –Typically the following steps will be used for groundwater screening:

i. Prior to advancing the first field screening point, the depth to groundwater shall be gauged in existing monitoring well(s).

ii. The initial field screening points should be installed in a radial pattern beginning in the immediate vicinity of the suspected source(s). These field screening points shall not be advanced deeper than five feet below the water table as gauged in existing wells and shall delineate the horizontal extent of free phase product and dissolved CoC at the water table. A series of temporary wells may be appropriate to define the extent of free phase product. If advancement refusal is encountered at multiple points, the UST Management Division Manager should be called to determine if field screening should be continued.

iii. Once the upper horizontal extent of the plume has been identified, a minimum of three deeper field screening points shall be advanced to determine the vertical extent of CoC in the soil and groundwater. These points shall be located along the plume centerline and shall be located at the source, the mid-point of the plume, and at the downgradient boundary of the plume. Water samples shall be screened for petroleum constituents at five-foot intervals and at any discernable changes in soil type with a properly calibrated field screening instrument. Changes in soil type can be identified utilizing well logs from existing monitoring wells or based on significant changes in the advancement rate of the field screening points. The deeper field screening points shall be terminated at advancement refusal or upon two consecutive samples below risk-based screening levels, whichever is shallower.

iv. The remaining field screening points for horizontal delineation shall be advanced to the depth that exhibited the highest results in the deeper field screening points.

For example, if the highest concentration of petroleum is present in a sand stringer located eight feet below the water table, then additional field screening points shall target that stratigraphic interval.

v. The contractor shall provide the following QA/QC information in their Tier II Assessment plan.

a. FIELD INSTRUMENT - The brand name, model number, and serial number for each instrument utilized.

b. FIELD CALIBRATION - Written verification of the calibration of the instrument in the field for each day of reported analysis. This shall include the method of calibration, the concentration(s) and composition of the standard, and the existing conditions at the time of calibration (temperature, humidity, etc.). This calibration shall be accomplished using a standard indicative of the constituents being tested for (i.e., if analyzing for gasoline, calibrate the instrument with gasoline). This allows the method to provide measurements of the actual concentration of the subject constituent (parts per million TPH as Gasoline) instead of span gas equivalents.

c. FIELD ANALYTICAL METHOD - This shall include protocols for sample collection and handling, as well as a detailed description of the field analysis. This shall also include information pertaining to the basis for the method and how it works.

7. Abandonment of temporary soil borings, field screening points, and core holes shall be by forced injection tremie grouting of neat cement from the termination depth of the boring/point to within three inches of the surface or up to six inches in a high traffic area under the supervision of a South Carolina certified well driller. The upper three inches of each boring, or up to six inches in a high traffic area, that is not completed as a monitoring well shall be filled with a material comparable to the surrounding material. For example, an asphalt plug should be placed in the upper three inches of a boring advanced in an asphalt parking lot, and a native soil/grass plug may be used in the upper three inches of a boring advanced in a grassy area.

A. <u>Any reference, or lack thereof, to any specific assessment or remedial technology does not constitute an endorsement or recommendation by the Department</u>. Technologies are discussed for illustrative purposes only. Any technology, which accomplishes the Tier II performance standards and meets all regulatory requirements, is acceptable.

B. <u>Field screening results (OVA and laboratory data), along with proposed monitoring well locations, are to be faxed to the UST project manager at (803) 896-6241 before installation of monitoring wells for concurrence.</u>

8. Install monitoring wells - The number and location of the monitoring wells shall be based on field screening results and with the concurrence of the UST Project Manager. The wells shall be installed in

locations that fully delineate the horizontal and vertical extent of the groundwater CoC so that all exposure pathways can be monitored. The monitoring wells shall define the extent of the CoC to the maximum extent possible without the installation of unnecessary monitoring wells.

A. Monitoring wells must be installed as regulated by the South Carolina Department of Labor, Licensing and Regulation and be constructed in compliance with South Carolina Well Standards, R.61-71. The well(s) must be installed under the direct supervision of a South Carolina certified permanent well driller and constructed in compliance with the South Carolina Well Standards and Regulations, R.61-71.H. The wells will require proper filter pack, grout, well identification plate, locking well cap, well pad constructed at or above ground level, and well cover held in place with bolts or screws. Any monitoring well(s) completed in traffic areas should be flush-mounted. All other wells should be completed with a one-foot minimum stick-up casing. The screen of all shallow monitoring wells must be installed so that the water table is bracketed. During well installation, soil samples are to be collected for screening at five-foot intervals. The soil lithology of each sample is to be recorded on a drilling log. The log shall contain the soil type, color of soil using standard methods, rocks or minerals present, split-spoon sample intervals, and any organic vapor and field screening measurements. Additionally, a qualitative indication of soil conditions (dry, moist, wet, saturated) shall be noted on the log. The boring log shall note the depth of each sample submitted for analysis. Enclose the boring log in and signed DHEC Form 1903, *Water Well Record* in the appropriate appendices of the final report (See Section A9).

B. A minimum of three vertical assessment wells should be proposed unless the vertical extent of the contamination can be reasonably determined, or estimated, by another method or if the geology precludes the potential of vertical migration of the CoC. The deep wells are to be paired with water table wells (preferably the water table well with the highest concentration of CoC, another water table well in the center part of the down gradient portion of the plume, and the first clean down gradient well) to determine vertical extent of the CoC and the vertical hydraulic gradient. If the deeper zone is confined or semi-confined, lateral deep wells may be necessary to accurately characterize flow conditions in the deeper zone. The diameter of the deep well boring must be such that installation of the telescoping monitoring well can easily be accomplished. A six-inch ID well casing shall be advanced at least ten feet deeper than the bottom of the adjacent water table well screen or to the first confining unit, whichever is less. The well screen length shall typically be five feet. The well will be installed as regulated by the South Carolina Department of Labor, Licensing and Regulation and be constructed in compliance with South Carolina Well Standards, R.61-71.

C. Unnecessary monitoring wells shall not be installed (e.g., wells installed a significant distance beyond an existing temporary or permanent well that exhibits no appreciable concentration of CoC or deep wells installed where groundwater analyses indicated minimal concentration of CoC in the shallow monitoring wells).

D. All soil cuttings and groundwater generated during boring construction and monitoring well development/purging shall be temporarily stored in suitable, leakproof containers and removed for disposal within 90 days of generation.

E. If free product is not encountered, the well shall be properly developed prior to sampling and the pH, temperature, dissolved oxygen, and specific conductance measured and reported. Development will be considered complete once enough solids, drilling muds and fluids have been removed to provide relatively sediment-free groundwater samples that are typical of the aquifer.

F. Depth to water (or product) shall be determined using equipment capable of detecting the free product/water interface prior to development. If free product is present, the apparent thickness to 0.01-foot accuracy shall be measured.

9. Groundwater Sampling – Groundwater samples should be collected after each new groundwater-monitoring well is developed and allowed to equilibrate for a minimum of twenty-four (24) hours.

A. If the monitoring well contains free product exceeding 0.01 feet (1/8 inch), a sample shall not typically be collected. If free product is encountered, please contact the appropriate UST project manager to determine if a product bail down test, collection of a product sample for product aging, or collection of a groundwater sample below the product will be required.

B. The well shall be purged prior to sampling with pH, temperature, dissolved oxygen, and specific conductance of the groundwater monitored and recorded. Purging is considered complete once the groundwater temperature and pH measurements have equilibrated. Field data sheets documenting purging volumes and parameters measured shall be included as an attachment to the report of findings. All purge water shall be containerized and disposed of as appropriate. Once laboratory analysis for soil and groundwater is received, the UST Management Division manager may be contacted to see if on site disposal is appropriate.

C. If the well is an existing well and the screen brackets the water table then the dissolved oxygen level will be recorded and the groundwater collected without purging the well.

D. If the well is an existing well and the screen does not bracket the water table (e.g., deep or pit cased well) then the well shall be purged prior to sampling and the pH, temperature, dissolved oxygen and specific conductance recorded. Purging is considered complete once the groundwater temperature and pH measurements have equilibrated. Field data sheets documenting purging volumes and parameters measured shall be included as an attachment to the report of findings. All purge water shall be containerized and disposed of as appropriate. Once laboratory analysis for soil and groundwater is received, the UST Management Division manager may be contacted to see if on site disposal is appropriate.

10. Groundwater Analysis - The groundwater samples shall be submitted to a South Carolina certified laboratory for analysis of:

Benzene
Toluene
Ethylbenzene

Oxygenates:
Methyl tert-Butyl Ether (MTBE)
3,3-Dimethyl-1-butanol

Xylenes	Ethyl Tert-butyl Ether (ETBE)
Naphthalene	Tert-amyl Methyl Ether (TAME)
Polynuclear aromatic hydrocarbons (PAHs)	Tert-butyl Alcohol (TBA)
Ethylene Dibromide (EDB)	Tert-amyl Alcohol (TAA)
1,2 Dichloroethane (1,2 DCA)	Tert-butyl Formate (TBF)
	Di-isoproyl Ether (DIPE)

Table 7 Groundwater Analytes

A. Samples from sites with a waste oil release shall also be analyzed for the 8 RCRA metals, as total metals (lead, mercury, arsenic, barium, cadmium, chromium, selenium, and silver).

B. All industry and South Carolina certification quality assurance and quality control methods, as well as those listed in the EPA approved methodology and this QAPP, shall be followed for shipping (sample labels, sealed sample containers, completed chain of custody forms, shipment to the laboratory on ice).

<u>Note: The elapsed time between the collection date of the groundwater samples and the received date of the report will be no more than 60 days</u>.

11. Aquifer Characteristics - Determine aquifer characteristics. The completion of a pumping test is preferred whenever possible. In cases where a pumping test cannot be conducted because of technical (e.g., well yields are too low) or financial (e.g., wastewater disposal is cost-prohibitive) reasons, aquifer slug tests shall be acceptable. All wastewater generated during aquifer tests shall be properly containerized and disposed.

    A. Slug Tests – Typically at least three separate slug tests shall be conducted in different on-site wells to determine aquifer characteristics unless otherwise specified by the Department. At least one slug test shall be conducted in a deep well. Data shall be analyzed in accordance with industry standards (Hvorslev, Bower and Rice, etc.). The slug test shall be reported on the <u>Summary of Slug Test form</u>. The form and all applicable date must be included in the appropriate appendix in the final report.

    B. Pumping Test - To ensure that the pumping test data is representative, the test shall be conducted using a sufficient pumping rate and duration to stress the aquifer. Therefore, the pumping test shall have a+ duration of at least six hours to a maximum of twenty-four hours based on site-specific data. Data shall be reported and analyzed in accordance with industry standards. Generation of more than 5,000 gallons of wastewater during a pumping test will require a general discharge permit from the Bureau of Water.

12. Free Product Recovery Test - If 0.2 foot or 2.4 inches or more of free product is encountered in a non-temporary monitoring well, then a recovery test or bail down test shall be conducted using current

industry standards to determine free product recovery rates and true thickness. This data shall be submitted on a graph as an appendix to the report.

13. CoC Fate and Transport - If requested by the Department and not previously calculated, calculate the SSTLs for each CoC for groundwater and for vapors. The contractor shall specify in the Contractor's Addendum the model or method proposed if fate and transport modeling is requested by the UST Management Division manager. The completion of a relatively simple mathematical and/or algebraic or semi-analytical expression shall be preferred initially. Where a completed pathway may exist, a more complex computer model shall be used.

    A. Mathematical and/or algebraic or semi-analytical expressions. For groundwater, the contractor shall utilize Domenico's Fate and Transport Model provided in Appendix G or an equivalent model. RBSL values should not be recalculated, if values are listed in Appendix C.

    B. Computer fate and transport modeling. For groundwater, the contractor shall utilize SOLUTE, AT123D, BIOPLUME-II, or an equivalent model. For vapors, the contractor shall utilize Farmer, Thibodeaux-Hwang, SeSoil, Jury, Box, or an equivalent model.

14. Tier 2 Risk Evaluation - Use the historical data and the information obtained during this scope of work to perform a Tier 2 Risk Evaluation. This evaluation includes, but is not limited to, the establishment of exposure points (current and future/potential receptors), site-specific target levels, and points of compliance and recommendations for future actions. This evaluation shall be performed in accordance with the RBCA document. The UST Project Manager must approve the receptor(s) prior to modeling and the model(s) to be used. Only one tier evaluation will be required for a facility unless new receptor(s) are identified.

15. Final Survey - A final survey to tie-in field screening points and permanent monitoring well locations and elevations to a common elevation datum shall be performed. A subsequent survey may be performed by the contractor.

16. Waste Disposal - Sample, analyze, transport within 90 days of generation, and dispose of any soil or wastewater generated in accordance with the Department's guidelines. Sampling and disposal shall be the responsibility of the contractor. It is the responsibility of the contractor to acquire signatures for the disposal manifests. Categories of waste disposal include:

    A. Wastewater - Water generated from well development, purging and/or sampling, or water generated from aquifer testing

    B. Free Product - any product recovered from the sub-surface.

    C. Soil - soil that requires treatment in concurrence with the Department.

17. Management of data and method - If the analytical method detection limits for soil or groundwater are above the risk-based screening levels (RBSL) as outlined in Appendix C, or the horizontal and vertical extent of the plume are not defined, the Department cannot consider a closure or no further action

decision. The UST project manager shall be notified at (803) 896-6241 at the earliest opportunity if any water samples are collected within a 500-foot radius of the edge of the plume.

Site Rehabilitation

This section outlines the criteria for Site Rehabilitation of petroleum releases from regulated underground storage tanks (UST) and is designed to meet the applicable requirements of the South Carolina Underground Storage Tank Control Regulations, R.61-92 Part 280, and the SUPERB Site Rehabilitation and Fund Access Regulations, R.61-98.
Confirmed releases of petroleum or petroleum products where concentrations of Chemicals of Concern (CoC) are documented to be in excess of risk-based screening levels (RBSLs) require Site Rehabilitation. The SSTL is the maximum concentration each CoC can exist above the RBSL to ensure current or potential receptors are not adversely affected.

Based on the concentration of each CoC and its potential risk to receptors, two processes of Site Rehabilitation are possible: A) active Site Rehabilitation and B) intrinsic remediation or natural attenuation.

1. Active Site Rehabilitation – This term is synonymous with active remediation and refers to physical actions taken to reduce the concentrations of CoC. Active Site Rehabilitation is applicable where:

   A. The concentration of any CoC exceeds the SSTL and must be reduced to prevent an impact to an actual or potential receptor;

   B. Free phase product is present with a thickness greater than 0.01 feet or 1/8 inch; or

   C. The plume continues to increase in size, CoC continue to migrate away from the source, or the concentration of any individual CoC is increasing.

2. Intrinsic Remediation or Natural Attenuation - These terms refer to the naturally occurring microbial and fate and transport processes that results in a reduction of the total mass of hydrocarbons. Intrinsic remediation is applicable where:

   A. The concentration of any CoC exceeds the RBSL but is less than the SSTL;

   B. Measurable free product is not present;

   C. The CoC plume is at or approaching equilibrium (i.e., the advancement of the plume is slowing down), and the concentration of a CoC is not increasing at any point;

   D. The predicted impact on actual or potential receptors does not exceed the RBSL at any time (i.e., no predicted risk to human health or the environment); and

   E. All conditions for intrinsic remediation can be verified in 18 months or less.

An intrinsic approach may need to be upgraded to active Site Rehabilitation if the above conditions cannot be demonstrated; a new or potential receptor is identified, or if there is a change in land use or zoning ordinances.

ACTIVE SITE REHABILITATION PROCEDURES

Once the extent and severity of contamination is identified and a cleanup goal or SSTL is established, the SSTL mass of petroleum to be removed is established.

1. Data collection - Prior to implementation of Site Rehabilitation, the horizontal and vertical extent of CoC in the soil and groundwater, aquifer characteristics, and SSTLs are determined. This data is typically collected during Tier 1, Tier 2, and Tier 3 assessments as described in this document.

2. Site Rehabilitation Plan and Permit Preparation – The contractor should submit a Site Rehabilitation Plan and any necessary permit applications to the Department in accordance with the schedule outlined by the UST Management Division. The Site Rehabilitation Plan should include, at a minimum:

   A. A brief description of how the proposed technology (ies) will reduce the concentrations of CoC at each compliance well to the established Site-Specific Target Level (SSTL). Scientific models, computations, and/or data from other case studies should be included which establish a predicted radius of influence and justify the proposed locations of recovery or injection wells, trenches, and other features.

   B. Proposed construction details for all temporary and permanent wells, trenches, or other features that will be needed to implement the Site Rehabilitation. Their locations should be depicted on a site map in addition to other pre-existing features such as monitoring wells, and aboveground structures. Please note that the locations of proposed construction should be discussed with the property owner with minimal disruption to any existing commercial or residential uses.

   C. A copy of the relevant portion of the tax map shall be included with a list of the property owner's names, tax map numbers, and mailing addresses for each property that: a) is currently impacted by petroleum, b) may become impacted by petroleum, c) has monitoring wells on it, or d) adjoins a property that fits in categories a), b), or c).

   D. A brief description of how any waste materials (wastewater, impacted soil, air) that may be generated will be handled.

   E. A brief description of any potential exposure that the contractor or other citizens may face during the cleanup process and how these potential exposures will be managed to prevent any risk to human health.

   F. A detailed monitoring proposal that complies with that required in the bid specification.

   G. A detailed description of the methods that will be used for deactivating and removing any wells and equipment added as a part of site rehabilitation.

H. An implementation schedule should be provided that outlines when the contractor will: a) initiate and complete construction, b) submit the baseline monitoring report, c) initiate Site Rehabilitation(s), d) submit quarterly Site Rehabilitation system evaluation reports, e) reach SSTLs, f) complete the post-remediation verification monitoring, and g) remove all equipment and abandon all wells as required by the bid specification. It is recognized that items e), f), and g) are estimates.

I. A completed Bureau of Air Quality Modeling Form should be submitted with the CAP if air emissions will be generated.

J. An Underground Injection Control Permit Application is required if injection of any solid, liquid, or gas (including ambient air) is proposed. If the injectate includes nutrients, microorganisms, or chemicals, a review of its safety by the state toxicologist is necessary unless previously conducted. If it has already been reviewed for another site, please provide a copy of the review memorandum.

3. Bioremediation Safety Guidelines – To evaluate the safety of a proposed injectate, the following information, at a minimum, is needed:

A. Manufacturers name, address, telephone number, and authorized representative for data disclosure.

B. SCDHEC project manager and telephone number.

C. Site contact person, address, and telephone number.

D. Contractor applying product, contact person, address, and telephone number.

E. A map depicting the site and the locations of all local private and public water supply wells.

F. Analytical results from a certified laboratory quantifying the CoC present in the soil.

G. Genus/species/strain of microorganism(s) contained in product (if requested, this will be maintained as confidential information).

H. Identity of specific nutrients and other additives contained in the product (if requested, this will be maintained as confidential information).

I. Documentation of evidence from authoritative technical references (e.g., Bergey's, etc.) that the microorganisms are not pathogenic to animals or humans.

J. Documentation that microorganisms are naturally occurring in the immediate or similar environment.

K. Documentation of specific degradation products expected.

L. Documentation of migratory potential of contaminants and degradation products in soil groundwater, and air.

M. Complete description of the bioremediation process on a site (e.g., application of the product to soil and/or groundwater, aeration of the soil, procedures needed to maintain microbial growth and chemical degradation).

N. Complete description of all potential exposure avenues to humans, animals, and the environment of contaminants and contaminated materials.

O. Disposal procedures for all contaminated materials, which result from the bioremediation process.

4. Public Notice - Pursuant to the South Carolina Underground Storage Tank Control Regulations, R.61-92, Section 280.67, the Department provides notice to the public of pending Site Rehabilitations. The method of notification is tailored in each situation to reach those members of the public directly and indirectly affected by the planned Site Rehabilitation. Notices may be posted at or in the vicinity of the site. Notices may also be provided to the owner or operator of the underground storage tanks that are suspected to be the source, and owners of local property that: a) is currently impacted by petroleum, b) may become impacted by petroleum, c) has monitoring wells on it, or d) adjoins to property that fits in categories a), b), or c). The duration of the public notice should be long enough to give the public a chance to provide their comments (usually 14 to 30 days). If the comments and questions received cannot be adequately answered on an individual basis or if a large number of people have questions, a meeting may be scheduled in their local area at a time suitable to encourage participation. The UST owner or operator and/or the site rehabilitation contractor may be invited to the meeting to further discuss the rehabilitation actions proposed in the Site Rehabilitation Plan.

5. Notice to Proceed – Once the public notice process and all permits have been issued, the Department will issue a notice to proceed with Site Rehabilitation. This notice does not imply any endorsement that the proposed method will work or that it will achieve the standards (SSTLs) in the most efficient manner possible. The contractor is responsible for ensuring that the system achieves the required results and for any necessary additions or modifications to the system to achieve the required results. The Department should receive prior notification of any proposed changes (other than changing pumping, injection, or air pressure rates). A comprehensive round of groundwater samples will be required prior to initiation of the treatment process outlined in the Site Rehabilitation Plan. Analytical parameters will be specified in the bid specification.

6. Site Rehabilitation System Evaluations – Quarterly Site Rehabilitation system evaluations (CASE) and monitoring reports documenting progress must be submitted. The reporting schedule will be outlined in the bid specification. Each CASE should include the following, at a minimum:

A. Brief description of any construction or treatment system adjustments completed by the site rehabilitation contractor since the previous report. Well completion logs and treatment system construction schematics may be included in the appendix.

B. A table summarizing the measurement of any observed free product and groundwater potentiometric data. In addition, a brief description and a map depicting the most current groundwater flow direction and gradient and any observed historical trends, should be included.

C. A table summarizing the historical and current analytical results from all monitoring wells, which are required to be sampled pursuant to the bid specification. Cleanup goals or SSTLs should also be noted. The total mass exceeding SSTL should be calculated in accordance with the formula and example included in Section H. Negative values should not be used.

D. A brief discussion should be included which describes the contractors' on-going efforts to maximize the time efficiency of the treatment process.

E. A revised implementation schedule should be included which more accurately estimates when the cleanup process will be complete.

F. Site maps, analytical results, well purging records, and any applicable soil or water disposal manifests should be included in the appendix.

7. Calculation of % mass removed– The following formula will be used to calculate the percent total mass reduction: total mass above the cleanup goal or SSTLs from initial sampling less total mass above cleanup goal or SSTLs from subsequent sampling divided by total mass above cleanup goal or SSTLs from initial sampling.

The following is an example to demonstrate the CoC Mass Reduction Calculation:

Well		Benzene	Toluene	Ethylbenzene	Xylene	MTBE	Naphthalene	Mass>SSTL
MW-1	Initial [A]	7,500	4,000	2,000	15,000	3,000	1,000	[A]
	SSTL [B]	10	2,000	1,400	10,000	80	50	[B]
	Initial > SSTL [C]	7,490	2,000	600	5,000	2,920	950	18,860 [C]
	Subsequent [D]	3,000	1,000	900	13,000	2,000	5	[D]
	SSTL [E]	10	2,000	1,400	10,000	80	50	[E]
	Subsequent > SSTL [F]	2,990	0	0	3,000	1,920	0	7,910 [F]
MW-4	Initial [G]	150	400	50	250	300	25	[G]
	SSTL [H]	5	400	50	250	40	25	[H]
	Initial > SSTL [I]	145	0	0	0	260	0	405 [I]
	Subsequent [J]	100	100	1	1	100	1	[J]
	SSTL [K]	5	400	50	250	40	25	[K]
	Subsequent > SSTL [L]	95	0	0	0	60	0	155 [L]
Totals	Initial > SSTL [M]	(sum of initial mass above SSTL for all wells) (C+I)						19,365 [M]
	Subsequent > SSTL [N]	(sum of subsequent mass above SSTL for all wells) (F+L)						8,065 [N]

Table 8 CoC Mass Reduction Calculation Example

Notes:

* If subsequent sampling indicates a CoC concentration value at or below the cleanup goal or SSTL and/or a CoC concentration below laboratory detection level but reporting level less than cleanup goal or SSTL for any constituent, the value for the mass reduction will be 0 (no negative numbers).

- If subsequent sampling indicates a CoC concentration below the laboratory detection level but the reporting limit is greater than cleanup goal or SSTL, the value for any constituent will be the analytical reporting limit.

Mass Reduction Calculation
CoC Mass Reduction = (M-N) = (19,365-8,065) = 0.5835 *100 = 58.35% CoC Reduction (M) 19,365

8. Completion of Active Site Rehabilitation – Once analytical results indicate that the concentration of each CoC at each monitoring point is below the cleanup goal or SSTL and the conditions in the site rehabilitation specification have been met, the contractor may request authorization from the Department to stop the treatment system. Once granted, the contractor will begin the post-remediation monitoring and verification cycle. The Department may require the installation of verification borings and wells. The number of verification points, analytical parameters, and the duration of the post-remediation verification process are specified in the site rehabilitation specification.

9. Once the verification process is complete and all concentrations of CoC are confirmed to remain less than the cleanup goal or SSTL, the Department will issue approval for the contractor to remove their Site Rehabilitation equipment, abandon pipe runs, and abandon monitoring wells.

INTRINSIC SITE REHABILITATION PROCEDURES

1. Data collection - Prior to implementation of Site Rehabilitation, the horizontal and vertical extent of CoC in the soil and groundwater, aquifer characteristics, and SSTLs are determined. This data is typically collected during Tier 1, Tier 2, and Tier 3 assessments as described in this document.

2. Basics of Intrinsic Remediation – Intrinsic remediation refers to the naturally occurring microbial and fate and transport processes that results in a reduction of the total mass of hydrocarbons. A monitoring program is implemented to gather the necessary data to support that intrinsic remediation is reducing the concentrations of CoC. Once the evidence documents that site conditions are suitable and that intrinsic remediation is taking place, an intrinsic Site Rehabilitation report (ICAR) is then prepared to justify the issuance of a Conditional No Further Action and the discontinuation of monitoring.

3. Monitoring - The primary evidence for intrinsic remediation shall be the observed reduction in the concentration of each CoC in each well and a corresponding reduction in the overall size and geometry of the plume.

4. Secondary evidence for intrinsic remediation includes further computer modeling of solute and transport rates or estimates of assimilative capacity, and the collection of geochemical parameters that support the depletion of nutrients or the generation of by-products as a result of biological or chemical processes. The most common geochemical parameters include: dissolved oxygen, temperature, nitrate, sulfate, ferrous iron, and methane. Other less common geochemical parameters that may also

help include: total organic carbon, redox potential, soluble salts, buffer index, soluble potassium, sodium, calcium, sulfur, boron, copper, zinc, cation exchange capacity, exchangeable ions, soluble phosphorous, and soluble manganese.

5. A monitoring well located hydraulically down gradient of the source is always needed to verify that the plume is not continuing to migrate. Initially all monitoring wells should be sampled for all CoC, which have concentrations exceeding the RBSL, and for secondary geochemical parameters. Accepted analytical methodologies are outlined in Appendix E. The data from the first sampling event should be evaluated for evidence of CoC reductions, plume migration, and biological or geochemical evidence of intrinsic remediation such as oxidation, de-nitrification, or methanogenesis. Sampling parameters for future events should be tailored to address those biological and geochemical parameters that provide the strongest evidence of intrinsic remediation.

6. Typically, quarterly sampling during the first year is needed to establish seasonal variability. The frequency after the fourth quarter should be established based on a review of all historical water table fluctuations and CoC variations.

7. Intrinsic Monitoring Report - Each monitoring report should include the following:

   A. A data table summarizing the measurement of any groundwater potentiometric data. In addition, a brief description and a site map depicting the most current groundwater flow direction and gradient and any observed historical trends should be included.

   B. A data table summarizing the historical and current analytical results of CoC and geochemical parameters from all monitoring wells, which were sampled.

   C. A brief description of any observed historical CoC concentration trends and any geochemical evidence supporting intrinsic remediation.

   D. Topographic and site maps depicting the locations of former or existing underground storage tanks lines and dispensers, monitoring wells, buildings, and other structures.

   E. Analytical results, well purging records, and any applicable soil or water disposal manifests should be included in the appendix.

8. Intrinsic Site Rehabilitation Plan - Once the monitoring program has gathered the needed evidence that supports that site conditions are suitable and that intrinsic remediation is taking place, an intrinsic Site Rehabilitation plan (ICAP) is prepared to justify the issuance of a “Conditional No Further Action” decision, and the discontinuation of monitoring. The ICAP contains the elements for the Intrinsic Monitoring Report and the following:

   A. A copy of the relevant portion of the tax map shall be included with a list of the property owner’s names, tax map numbers, and mailing addresses for each property that: a) is currently impacted by petroleum, b) may become impacted by petroleum, c) has monitoring wells on it, or d) adjoins to property that fits in categories a), b), or c).

B. All available data should be used to estimate how long intrinsic remediation will take to restore the soil and groundwater to risk-based screening levels. These estimates may be derived by extrapolation of documented decreasing trends, or through calibration of scientific models using historical CoC and geochemical data. All input parameters and assumptions should be clearly identified.

C. The receptor survey should be verified and the local city or county authorities should be contacted for an update on the current applicable zoning and land use ordinances. A brief discussion of the findings should be included.

D. If the data supports that no unacceptable risk will result by leaving the CoC in place to naturally degrade during the estimated clean-up time frame, the report should recommend the termination of monitoring.

NO FURTHER ACTION DECISION

1. A “No Further Action” decision may be issued by the Department if the concentration of each CoC is at or below the RBSL. The samples that support the decision should be:

   A. Collected from the location(s) deemed most likely to represent the worst case CoC;

   B. Analyzed for appropriate parameters by a laboratory certified in the state of South Carolina for those parameters; and

   C. Collected in accordance with industry standards for quality assurance and quality control.

2. If a Site Rehabilitation system was used, the “No Further Action” decision will only be issued after completion of a post-remediation monitoring program, which confirms that concentrations of each CoC remain below RBSL.

CONDITIONAL NO FURTHER ACTION DECISION

1. Pursuant to The SUPERB Site Rehabilitation and Fund Access Regulations, R.61-98, a “Conditional No Further Action” decision can be granted once the following has been demonstrated:

   A. the SSTL have been met;

   B. the CoC have reached equilibrium or are not moving at a significant rate;

   C. concentrations of CoC are not increasing;

   D. no unacceptable risk to human health, safety, or the environment exists; and

   E. concentrations of CoC will not exceed RBSL at the exposure point or receptor.

2. Prior to issuance of a "Conditional No Further Action" letter, the Department provides notice to the public to solicit comments and concerns. The method of notification is tailored in each situation to reach those members of the public directly and indirectly affected by the proposed decision.

3. A "Conditional No Further Action" letter is based on site-specific conditions and the current and reasonably anticipated future use of the site. The letter will outline all land use assumptions and conditions at the time the decision is made. The Department will be notified by the underground storage tank owner or operator within 30 days of any changes in the listed assumptions or conditions so that the potential risk can be re-evaluated. Examples of assumptions or conditions that may be attached to a "Conditional No Further Action" letter include, but are not limited to:

A. The property is zoned for commercial use and should remain commercial in the future.

B. Water wells are not currently installed in the impacted area and should not be installed in that area in the future.

C. Local ordinance precludes the installation of potable wells.

The Department maintains a Registry of Releases for all "Conditional No Further Action" decisions. The longitude and latitude from the Geodetic Information System, local tax map number, and street address of each closed conditional release is available at the Department's Freedom of Information office (803) 898-3882. If a person is later able to demonstrate all CoC are below the RBSL, then that person may request that the release be removed from the registry of releases and a "No Further Action" decision be issued by the Department.

WELL ABANDONMENT

Once the UST owner or operator is notified of a "No Further Action" or a "Conditional No Further Action" decision, abandonment of the monitoring wells is suggested to minimize the possibility of leakage of future spills into the groundwater aquifer. Abandonment shall be by a South Carolina certified well driller in accordance with the South Carolina Well Standards and Regulations, R.61-71. The UST owner or operator may also choose to keep these wells for future monitoring purposes. If this option is chosen, the UST owner or operator becomes responsible for the future maintenance and abandonment of the monitoring wells.

AFVR (Aggressive Fluid Vapor Recovery)

Aggressive Fluid Vapor Recovery (AFVR) is a technology that is used for rapid recovery of liquid phase hydrocarbons such as gasoline or diesel fuel. AFVR uses a high-pressure vacuum to recover both fluids (groundwater and liquid phase hydrocarbons) and vapor phase hydrocarbons from monitoring or recovery wells.

1. Prior to the initiation of the event, fluid levels and free product thickness measurements shall be recorded in the wells designated by the Department as potentially containing free product.

2. On a site-specific basis, the duration of the recovery event may be greater than the allotted eight-hour time frame. Additional mobilizations may be necessary in the event that the recovery tanker becomes filled and disposal is necessary at that time, in order to continue the recovery process. In this instance, an additional mobilization may be added. In these instances, prior approval must be obtained from the UST Management Division.

3. Magnehelic gauges must be installed on the extraction wells and monitoring wells immediately surrounding the extraction wells. The range of each magnehilic gauge should be selected based on the expected pressure range. For example, one would expect perimeter wells to have less vacuum than the extraction wells and smaller graduate interval may be necessary.

4. Connect the vacuum truck or treatment unit to a grounded metal object with a ground lead to ensure that static electricity does not result in an explosion hazard.

5. The AFVR should be completed by establishing a vacuum on the subsurface through the existing monitoring wells. The unit must be capable of providing a minimum airflow of 250 cubic feet per minute (CPM) at 25 inches Mercury vacuum. An airtight seal must be established on the top of each extraction well. Drop tubes inserted in the well(s) should have an inside diameter of at least one (1) inch and should initially be installed six inches below the bottom of the product or the top of the well screen whichever is deeper. The drop tubes should be lowered deeper in the well only if the well exhibits slow recovery (repeatedly goes dry) or if it is deemed necessary to establish a steeper hydraulic gradient to enhance free product migration toward the well. The goal is to maximize the recovery of free product and petroleum vapors in the capillary fringe and minimize the recovery of ground water.

6. The AFVR should be completed as one continuous event (typically eight hours in length). The AFVR shall not be terminated early without prior approval from SCDHEC. The contractor must have sufficient materials and pressure to simultaneously recover from a minimum of three wells located within a 50-foot radius of each other. If all wells requiring AFVR are not located within a 50-foot radius of each other, AFVR activities may rotate between areas during the event. Recovery shall concentrate on the well(s) that demonstrate the highest free product removal rate, unless otherwise directed by the Department.

7. The airflow rate, volatile air emission concentrations, and magnehelic gauge readings shall be measured and recorded at a minimum every thirty minutes through the duration of the recovery event.

8. If the air emissions are anticipated to have an adverse impact in the vicinity of the AFVR, the Department may require off-gas treatment.

9. A report documenting the recovery event shall be submitted within thirty days from the date of the event. The report shall include the following:

   A. A brief description of the completed work scope and any relevant descriptions pertaining to the data tables.

B. A table summarizing the airflow (in CPM) and volatile concentrations collected from the stack of the truck every thirty minutes through the duration of the event. The table shall also document which well(s) were being recovered from during that time interval.
C. A table summarizing the magnehelic gauge measurements from all applicable wells on a thirty-minute time interval.

D. The total volume of water recovered (gallons).

E. The total volume of free phase product recovered (typically measured with a product/water interface device inserted into the top of the tanker at the completion of the event and then converted to an approximate volume).

F. The total mass of petroleum removed as vapor. This is calculated based on the airflow rate and the concentration of vapor.

G. A table documenting the free product thickness in each well before and after the recovery event.

H. Scaled base map depicting the location of the extraction wells and the surrounding wells equipped with magnehelic gauges.

I. Recovered free phase petroleum and groundwater must be accepted by a permitted treatment facility. There can be no spillage or leakage in transport. A copy of the disposal manifest from the receiving facility that clearly designates the quantity received must be included as an appendix to the final report.

NOTE: These specifications detail the specific tasks required to successfully complete the scope of work for AFVR. These specifications do not include general implied tasks as required by Federal, State or local governments (OSHA 40-hour training, Health and Safety Plans, business licenses, etc.).

Groundwater Sampling Events

Groundwater samples should be collected after each new groundwater-monitoring well is developed and allowed to equilibrate for a minimum of twenty-four (24) hours.

1. If the monitoring well contains free product exceeding 0.01 feet (1/8 inch), a sample shall not typically be collected. If free product is encountered, please contact the appropriate UST project to determine if a product bail down test, collection of a product sample for product aging, or collection of a groundwater sample below the product will be required.

2. The well shall be purged prior to sampling with pH, temperature, dissolved oxygen, and specific conductance of the groundwater monitored and recorded. Purging is considered complete once the groundwater temperature and pH measurements have equilibrated. Field data sheets documenting purging volumes and parameters measured shall be included as an attachment to the report of

findings. All purge water shall be containerized and disposed of as appropriate. Once laboratory analysis for soil and groundwater is received, the UST Management Division manager may be contacted to see if on site disposal is appropriate.

3. If the well is an existing well and the screen brackets the water table then the dissolved oxygen level will be recorded and the groundwater collected without purging the well.

4. If the well is an existing well and the screen does not bracket the water table (e.g., deep or pit cased well) then the well shall be purged prior to sampling and the pH, temperature, dissolved oxygen and specific conductance recorded. Purging is considered complete once the groundwater temperature and pH measurements have equilibrated. Field data sheets documenting purging volumes and parameters measured shall be included as an attachment to the report of findings. All purge water shall be containerized and disposed of as appropriate. Once laboratory analysis for soil and groundwater is received, the UST Management Division manager may be contacted to see if on site disposal is appropriate.

5. Groundwater Analysis - The groundwater samples shall be submitted to a South Carolina certified laboratory for analysis of those parameters requested by the UST Management Division.

6. All industry standard quality assurance and quality control methods shall be followed for shipping (sample labels, sealed sample containers, completed chain of custody forms, shipment to the laboratory on ice).

The elapsed time between the collection date of the groundwater samples and the received date of the report will be no more than 60 days.

Monitoring Well Installations

Additional monitoring wells are installed in instances where additional wells are required for plume delineation.

1. If the location(s) for permanent monitoring wells cannot be determined without field screening, the contractor will utilize a field sampling technique (vapor or water sample collection) and analyze each sample in the field with an appropriate screening methodology. The method for sample collection and the field screening technique (FST) shall be included in the required Contractor Addendum. The field screening shall serve as a tool to determine adequate locations for monitoring wells addressing horizontal and/or vertical extent of the petroleum constituents in soil and groundwater during one direct push/drill rig mobilization. The contractor shall use an appropriate technique for each site. The results of the field screening will be to optimally locate and reduce the number of permanent monitoring wells. Contractors are allowed per project manager’s request to collect groundwater samples from existing shallow wells, deep wells, and down gradient screening points for laboratory analysis to ensure the entire plume is delineated. Field screening locations, field sampling results, any laboratory analyses, and proposed permanent monitoring well locations are to be faxed or e-mailed to the DHEC project manager for concurrence prior to the installation of permanent wells. Abandonment of temporary soil borings, field screening points, and core holes shall be by forced injection or tremie grouting with neat

cement from the termination depth of the boring/point to within three inches of the surface under the supervision of a South Carolina certified well driller. The upper three inches of each boring that is not completed as a monitoring well shall be filled with a material comparable to the surrounding material. For example, a native soil/grass plug may be used in the upper three inches of a boring advanced in a grassy area. If for any reason the property owner requests a variance (i.e., do not grout the hole) the project manager will be contacted within 2 business days of the request and the request will be documented in the report of findings.

2. Construct permanent monitoring wells of two-inch diameter PVC casing with a ten-foot PVC screen in the area designated by the UST Project manager. The well(s) must be installed under the direct supervision of a South Carolina certified permanent well driller and constructed in compliance with the South Carolina Well Standards and Regulations, R.61-71.H. The wells will require proper filter pack, grout, well identification plate, locking well cap, well pad constructed at or above ground level, and well cover held in place with bolts or screws. Information on the well identification plate will be stamped, etched, or engraved in legible text. Use of ink markers (e.g., "Sharpie®") is not allowed. Any monitoring well(s) completed in traffic areas should be flush-mounted. All other wells should be completed with a one-foot minimum stick-up casing. The screen of all shallow monitoring wells must be installed so that the water table is bracketed. The well must be properly developed. The development method shall be capable of removing enough formation cuttings, drilling fluids and additives to provide relatively sediment-free water samples that are typical of the aquifer. All development water must be containerized and disposed of as appropriate.

3. Describe the lithology of each soil sample collected during well installation and screen for organic vapor concentrations using properly calibrated instruments or test kits (e.g., immunoassay). Soil lithology and field-screening information should be documented on the well logs. For waste oil UST assessments, note any staining observed. When it is requested to analyze the soil samples please do so in accordance with Section B4 of this document. When grain size/hydrometer analysis is requested determine the sand/silt and silt/clay fractions at 0.074 millimeters (#200 screen) and 0.004 millimeters, respectively. The report shall give the percentage of sand, silt, and clay.

4. Collect groundwater samples from monitoring or water supply wells when requested. Analyses should be conducted in accordance with Section B4 of this document

5. If it is requested to conduct an aquifer slug test, record the change in the groundwater table vs. time data for each well. Evaluate the results of the slug test in accordance with commonly accepted methods (e.g., Bower and Rice, Hvorslev) and calculate seepage velocity. Enter data on the slug test form found at http://www.scdhec.gov/environment/lwm/forms/slugtest.pdf.

6. Store all soil, development and purge water generated during implementation in appropriate containers. Upon receipt of laboratory analytical results or 90 days whichever is sooner, properly dispose of the soil and wastewater in the appropriate manner. If the derived soil and wastewater is generated from a waste oil investigation, prior approval must be obtained from the Bureau of Land and Waste Management before offsite removal commences. Additionally, RCRA metals analyses to characterize the waste may be allowed if the permitted disposal facility requires such.

7. Perform survey to tie in the location and elevation of the newly installed monitoring well(s) to a minimum of two pre-existing monitoring wells. The survey should be scaled to reflect the existing site map. The accuracy of the subsequent survey will be of major importance. Determine monitoring well elevations from the top of casings.

8. Comprehensive Survey (if requested) should be conducted after completion of all field works (soil boring and monitoring well installation), a survey of the site shall be performed by a South Carolina Registered Surveyor. The survey should be accurate to 0.01 foot. The survey will cover an area measuring 500 ft by 500 ft and shall include, at a minimum, all of the following:
    a. the location of all manmade structures
    b. all above ground and underground utilities
    c. all potential receptors
    d. all existing and/or former USTs and associated piping and dispensers
    e. all monitoring wells associated with the release (elevation shall be measured to the top of casing of each monitoring well).

9. Repair damaged or missing items to previously installed monitoring wells as necessary. This activity will include replacement of a cracked or broken well pad, replacement of the well vault, replacement of a missing well tag, replacement of the well cover, bolts, well caps, and locks. A description of all repairs will be included in the report.

10. High strength well pad replacement shall consist of a steel-reinforced concrete well pad that will be able to support heavy vehicles such as fully loaded semi's or concrete trucks. This type of construction is appropriate at truck stops or sites that have heavy machinery driving over the monitoring wells.

11. When necessary, abandon monitoring wells in compliance with the South Carolina Well Standards and Regulations, R.61-71.H.

12. The final report (one [1] hard copy report and one [1] electronic copy) should be submitted and include the relevant elements as required in Section A9 of the document.

<u>Granulated Activated Carbon Unit Installation</u>

Granulated Activated Carbon Units may be installed on water supply wells to filter out petroleum compounds until a permanent source of potable water is obtained.

1. The unit must filter Volatile Organic Compounds (to include Benzene, Toluene, Ethylbenzene, Xylenes, Methyl tert-butyl Ether, etc.), and Polynuclear Aromatic Hydrocarbons.

2. The unit must have a minimum carbon capacity of two cubic feet or 50 pounds.

3. New units must have a minimum five-year warranty on the control head unit and a lifetime warranty on the tank.

4. The unit must have an automatic counter to keep account of water usage or a counter must be installed in conjunction with the unit.

5. The unit must have a 48-hour capacitor that will reset the equipment for backwashing purposes in the event of electrical failure.

6. The equipment specifications must be validated by the Water Quality Association.

7. The contractor will provide a six-month warranty on all pipe, fittings, etc. used in the installation of all units.

8. The unit will be installed inside the existing well house (space permitting) or inside a locked housing. The housing must be durable and blend with the surroundings. Copies of the key to the lock must be provided to the owner of the well and to the Underground Storage Tank Management Division.

9. The contractor will install sample taps on the inlet and outlet lines of the unit to allow for sampling. The sample taps must be located inside the locked housing for the unit. The installation will include up to ten (10) feet of pipe (Schedule 40 PVC) and all necessary materials and fittings. When installing a GAC unit close to a house or basement extra measures must be taken to control the runoff from the unit.

10. All electrical wiring will be installed in compliance with applicable codes. The installation will include up to twenty (20) feet of wire and all necessary conduit, fittings, trenching (as required), materials and labor.

11. A schematic diagram of the unit (new or old) with the model number, serial number, site name, UST permit number, inlet and outlet ports will be required. This information must be submitted within one week of installation.

12. A sign in sheet must be in the housing unit to indicate carbon changes and other service. The information must include the time, date, type of service, and the full name(s) of the personnel conducting the service.

13. The contractor must provide all calculations, using analytical data provided by the Department, for determining COC breakthrough and the frequency at which the filter material must be changed.

14. All work must be done by a professional plumber certified in the State of South Carolina. Proof of certification must be provided with the QAPP Addendum

15. The final report (one [1] hard copy report and one [1] electronic copy) should be submitted and include the relevant elements as required in Section A9 of the document.

<u>Abandonment of Monitoring Wells</u>

The UST Management Division may require the abandonment of monitoring wells that are no longer required or that have been damaged.

1. Abandon all monitoring wells at the assigned site under the direct supervision of a Class A, B, or C South Carolina-certified well driller. The wells must be filled from the termination depth to within six inches of the land surface with neat cement, bentonite-cement, or twenty (20) percent high solids sodium bentonite grout using forced injection by tremie pipe in accordance with the South Carolina Well Standards R.61-71. In paved areas, the vault will be filled with aggregate reinforced concrete or asphalt. In unpaved areas, the pad, vault, and cover will be removed and the space filled with soil to level with the surrounding land surface.

2. The final report (one [1] hard copy report and one [1] electronic copy) should be submitted and include the relevant elements as required in Section A9 of the document.

B2 Sampling Methods

Notes:
Deployment of in-situ monitoring (field analysis for pH, conductivity, etc) is discussed under Groundwater Sampling (See Monitoring_Well_Purging) and used for monitoring the purging of the wells. Information on the specifics of QC, calibration etc is discussed in Section B4 of both this QAPP and the Contractor's QAPP Addendums.

The Procedures for the decontamination of sampling equipment is given in Appendix_H. The individual Contractors are responsible for the disposal of the waste from such decontamination.

When problems occur in the field the Contractor is responsible for contacting the UST Project Manager within 24 hours. The problems are documented in field logs. The contractor is responsible for necessary corrective action.

Soil Sampling

1. Introduction
The appropriate equipment and techniques must be used to conduct the investigation. This section discusses the sampling equipment available and collection methods, which have been shown to be technically, appropriate.

2. Equipment
Soil sampling equipment used for sampling trace contaminants should be constructed of inert materials. Ancillary equipment such as auger flights, post hole diggers, etc. may be constructed of other materials since this equipment does not come in contact with the samples.
Selection of equipment is usually based on the depth of the samples to be collected, but it is also controlled to a certain extent by the characteristics of the material. Manual techniques and equipment such as hand augers, are usually used for collecting surface or shallow, subsurface soil samples. Power operated

equipment is usually associated with deep sampling but can also be used for shallow sampling when the auger hole begins to collapse or when the soil is so tight that manual auguring is not practical.

3. Sampling Methodology

This discussion of soil sampling methodology reflects both the equipment used (required/needed) to collect the sample, as well as how the sample is handled and processed after retrieval. Selection of equipment is primarily based on the depth of sampling, but it is also controlled, to a certain extent, by the characteristics of the material. Simple, manual techniques and equipment, such as hand augers, are usually selected for surface or shallow, subsurface soil sampling. As the depth of the sampling interval increases, some type of powered sampling equipment is usually needed to overcome torque induced by soil resistance and depth. The following is an overview of the various sample collection methods employed over three general depth classifications: surface, shallow subsurface, and deep subsurface. Any of the deep collection methods described may be used to collect samples from the shallower intervals.

A. Manual Collection Techniques and Equipment:

These methods are used primarily to collect surface and shallow subsurface soil samples. Surface soils are generally classified as soils between the ground surface and 12 inches below ground surface. The shallow subsurface interval may be considered to extend from approximately 12 inches below ground surface to 24 inches or to a site-specific depth at which sample collection using manual methods becomes impractical.

<u>The sample must be obtained from an area that is not in contact with metal sampler surface.</u>

1. <u>Surface Soils</u>

    a. Surface soils may be collected with a wide variety of equipment. Spoons, shovels, hand-augers, push tubes, and post-hole diggers (made of the appropriate material) may be used to collect surface soil samples. As discussed in the section on powered equipment, surface soil samples may also be collected in conjunction with the use of heavy equipment.

    b. Surface samples are removed from the ground and placed in pans, where mixing, as appropriate (Section 3.15.8), occurs prior to filling of sample containers. Section 11.4.1 contains specific procedures for handling samples for volatile organic compounds analysis. If a thick, matted root zone is encountered at or near the surface, it should be removed before the sample is collected.

2. <u>Subsurface Soils</u>

    a. Hand-augering is the most common manual method used to collect subsurface samples. Typically, auger-buckets with cutting heads are pushed and twisted into the ground and removed as the buckets are filled. The auger holes are advanced one bucket at a time.

    b. The practical depth of investigation using a hand-auger is related to the material being sampled. In sands, augering is usually easily accomplished, but the depth of investigation is controlled by the depth at which sands begin to cave. At this point, auger holes usually begin to collapse and cannot practically be advanced to lower depths, and further samples, if required, must be collected using some type of pushed or driven device.

c. Hand-augering may also become difficult in tight clays or cemented sands. At depths approaching 20 feet, torquing of hand-auger extensions becomes so severe that in resistant materials, powered methods must be used if deeper samples are required. Some powered methods, discussed later, are <u>not acceptable</u> for actual sample collection, but are used solely to gain easier access to the required sample depth, where hand-augers or push tubes are generally used to collect the sample.

d. When a vertical sampling interval has been established, one auger-bucket is used to advance the auger hole to the first desired sampling depth. If the sample at this location is to be a vertical composite of all intervals, the same bucket may be used to advance the hole, as well as to collect subsequent samples in the same hole. However, if discrete grab samples are to be collected to characterize each depth, a <u>new bucket</u> must be placed on the end of the auger extension immediately prior to collecting the next sample. The top several inches of soil should be removed from the bucket to minimize the chances of cross-contamination of the sample from fall-in of material from the upper portions of the hole.

e. Another piece of soil sampling equipment commonly used to collect shallow subsurface soil samples is the Shelby or "push tube". This is a thin-walled tube, generally of stainless steel construction and having a beveled leading edge, which is twisted and pushed directly into the soil. This type of sampling device is particularly useful if an undisturbed sample is required. The sampling device is removed from the push-head, then the sample is extruded from the tube into the pan with a spoon or special extruder. Even though the push-head is equipped with a check valve to help retain samples, the Shelby tube will generally not retain loose and watery soils, particularly if collected at lower depths.

B. Powered Sampling Devices

Powered sampling devices and sampling aids may be used to acquire samples from any depth but are generally limited to depths of 20 feet or less. Among the common types of powered equipment used to collect or aid in the collection of subsurface soil samples are power augers; split-spoon samplers driven with a drill rig drive-weight assembly or hydraulically pushed using drill rig hydraulics; continuous split-spoon samplers; specialized hydraulic cone penetrometer rigs; and back-hoes. The use of each of these is described below.

1. Power Augers - Power augers are commonly used to aid in the collection of subsurface soil samples at depths where hand augering is impractical. This equipment is a sampling aid and not a sampling device, and 20 to 25 feet is the typical lower depth range. It is used to advance a hole to the required sampling depth, at which point a hand auger is usually used to collect the sample.

2. Drill Rigs - Drill rigs offer the capability of collecting soil samples from greater depths. For all practical purposes, the depth of investigation achievable by this method is controlled only by the depth of soil overlying bedrock, which may be in excess of 100 feet. When used in conjunction

with drilling, split-spoon samplers are usually driven either inside a hollow-stem auger or inside an open borehole after rotary drilling equipment has been temporarily removed. The spoon is driven with a 140-pound hammer through a distance of up to 24 inches and removed. If geotechnical data are also required, the number of blows with the hammer for each six-inch interval should be recorded.

3. Back-Hoes - Back-hoes are often utilized in shallow subsurface soil sampling programs. Samples may either be collected directly from the back-hoe bucket or they may be collected from the trench wall if proper safety protocols are followed. Trenches offer the ability to collect samples from very specific intervals and allow visual correlation with vertically and horizontally adjacent material. Prior to collecting samples from trench walls, the wall surface must be dressed with a stainless steel shovel, spatula, knife, or spoon to remove the surface layer of soil that was smeared across the trench wall as the bucket passed. If back-hoe buckets are not cleaned according to the procedures described in Appendix H, samples should be collected from material that has not been in contact with the bucket surface.

C. Special Techniques and Considerations

Collection of Soil Samples for Volatile Organic Compounds (VOC) Analysis: These samples should be collected in a manner that minimizes disturbance of the sample. For example, when sampling with a hand auger, the sample for VOC analysis may be collected directly from the auger bucket or immediately after an auger bucket is emptied into the pan. Samples for VOC analysis are not mixed. Low-level samples must be collected in accordance with 5035 following the certification requirements as issued by the SCDHEC Office of Environmental Laboratory Certification.

1. Dressing Soil Surfaces - Any time a vertical or near vertical surface, such as is achieved when shovels or back-hoes are used for subsurface sampling, is sampled, the surface should be dressed to remove smeared soil. This is necessary to minimize the effects of cross-contamination due to smearing of material from other levels.

D. Specific Sampling Equipment Quality Assurance Techniques

All equipment used to collect soil samples should be cleaned as outlined in Appendix H and repaired, if necessary, before each use and before being stored at the conclusion of field studies. Equipment cleaning conducted in the field or field repairs should be thoroughly documented in field records.

E. Sample Handling and Shipment

All samples for volatiles analysis must be cooled, packed in appropriate containers, and shipped to the laboratory on ice, as described in Appendix F.

Groundwater Sampling

1. Introduction

Three data quality objectives have been identified for groundwater sampling including routine private well sampling, ambient water quality monitoring, and chemical investigation. Because the objectives have different goals, these procedures were designed to address the minimally acceptable criteria for all three data quality objectives.

Groundwater samples are usually obtained from either temporarily or permanently installed groundwater monitoring wells. They can also be obtained anywhere groundwater is present, such as in a pit or a dug or drilled hole.

Groundwater sampling procedures can be sub-divided into two areas, purging and sampling; each of which has different goals and objectives. Regarding purging, temporary and permanent wells are addressed separately because of their differing characteristics. Depending on the nature and type of well to be sampled, purging the well may or may not be required.

2. Water Level Measurements

The measurement of the groundwater level in a well is frequently conducted in conjunction with groundwater sampling to determine the "free" water surface. Water level measurements should occur prior to purging and sampling. This potentiometric surface measurement can be used to establish groundwater flow direction and gradients. Total well depth and groundwater level measurements are needed to determine the volume of water in the well casing prior to purging the well for sampling purposes.

All groundwater level and total depth measurements should be made relative to an established reference point on the well casing and should be documented in the field records. To be useful for establishing the groundwater gradient, the reference point should be tied in with the NGVD (National Geodetic Vertical Datum) or a local datum.

<u>Specific Groundwater Level Measuring Techniques</u>
Measuring the depth to the free groundwater surface can be accomplished by the following methods (5). Method accuracies are noted for each of the specific methods described below.

- <u>Electronic Water Level Indicators</u> -- This instrument consists of a spool of dual conductor wire, a probe attached to the end, and an indicator. When the probe comes in contact with the water, the circuit is closed and a meter light and/or buzzer attached to the spool will signal the contact. Penlight or 9-volt batteries are normally used as a power source. Measurements must be made and recorded to the nearest 0.01 foot.

- <u>Weighted Tape</u> -- This method is similar to the "bell sounder" method, except that any suitable weight, not necessarily one designed to create an audible pop, can be used to suspend the tape. The weight should, ideally, be made of a relatively inert material that can be easily cleaned. Measurements must be made and recorded to the nearest 0.01 foot.

- <u>Chalked Tape</u> -- Chalk rubbed on a weighted steel tape will discolor or be removed when in contact with water. Distance to the water surface can be obtained by subtracting the wet chalked length from the total measured length. The tape should be withdrawn quickly from the well because water has a tendency to rise up the chalk due to capillary action. Measurements must be made and recorded to the nearest 0.01 foot. This method is not recommended if samples are to be collected for analyses of organic or inorganic contaminants.

• Other Methods-- There are other types of water level indicators and recorders available. Accuracies for these methods vary and should be evaluated before selection. Any method that is not capable of providing measurements within 0.01 foot should not be used.

Specific Free Product Thickness Measuring Techniques
Measuring the thickness of free product can be accomplished by the following methods. Method accuracies are noted for each of the specific methods described below.

- Electronic Oil/Water Interface Probe - This instrument consists of a spool of dual conductor wire, a probe attached to the end, and an indicator. When the probe comes in contact with free product, the circuit is closed and a meter light and/or buzzer attached to the spool will signal the contact. When the probe comes in contact with water, a different signal is produced. Penlight or 9-volt batteries are normally used as a power source. Measurements must be made and recorded to the nearest 0.01 foot.

- Other Methods – There are other types of free product measurement devices available. Accuracies for these methods vary and should be evaluated before selection. Any method that is not capable of providing measurements accurate to within 0.01 foot should not be used.

Total Well Depth Measurement Techniques
The weighted tape, or electronic water level indicators can be used to determine the total well depth. This is accomplished by lowering the tape or cable until the weighted end is resting on the bottom of the well. In deep wells with long water columns, it may be difficult to determine when the tape end is touching the bottom of the well. Care must be taken in these situations to ensure accurate measurements. All total well depth measurements must be made and recorded to the nearest 0.01 foot. Equipment must be decontaminated between measurements at sites.

Specific Quality Control Procedures
Devices used to measure groundwater levels should be calibrated against the Invar steel surveyor's chain. These devices must be calibrated to 0.01 foot per 10 feet length. Before each use, these devices must be prepared according to the manufacturer's instructions (if appropriate) and checked for obvious damage. These devices must be decontaminated according to the procedures specified in Appendix H prior to use at the next well. All calibration and maintenance data must be recorded in a log book. The ground surface elevation and top of casing elevation at the wells must be determined by standard engineering survey practices.

3. Monitoring Well Purging

Purging and Purge Adequacy:
Purging is the process of removing stagnant water from a monitoring well immediately prior to collecting the sample to ensure that the sample is representative of actual aquifer conditions. In certain situations dictated

by the sampling technique or well-specific conditions, purging may not be necessary (see Diffusion Bag Samplers and No-Purge Sampling for Petroleum Releases descriptions below). In order to determine when a well has been adequately purged, field investigators must: 1) monitor the pH, specific conductance, temperature, and turbidity of the groundwater removed during purging; and/or 2) observe and record the volume of water removed. (For low-flow purging, other field parameters such as dissolved oxygen, may need to be monitored.) Purging must be conducted from the most upgradient well to the furthest downgradient well or from the least contaminated well to the most contaminated well if contamination is known. Prior to handling any purging or sampling equipment, clean disposable, powderless nitrile gloves must be worn.

The depth of water and depth of the well should be determined (if possible) before purging. Electrical water level indicators/well sounder, steel tape or chalk line can be used for this purpose. It is standard practice to mark the top of the well casing to provide a point of reference from which these measurements will be consistently made. Field investigators should look for these markings when taking these measurements. Extreme caution should be exercised during this procedure to prevent cross-contamination of the wells. This is a critical concern when samples for trace organic compounds or metals analyses are collected. At a minimum, the well sounding device must be cleaned by washing in a laboratory detergent solution, followed by rinses with tap water and analyte-free water. After cleaning, it must be placed in a clean plastic bag or wrapped in foil.

Prior to initiating the purge, the amount of water standing in the water column (water inside the well riser and screen) must be determined. To do this, the diameter of the well must be determined and the water level and total depth of the well must be measured and recorded. The water level is subtracted from the total depth, providing the length of the water column. Once this information is obtained, the volume of water to be purged can be determined using one of several methods. One is the equation:

$$V = 0.04d^2h$$

Where: h = depth of water in feet, d = diameter of well in inches , V = volume of water in gallons

Alternatively, the volume may be determined using a casing volume per foot factor for the appropriate diameter well, similar to that in Table 7. The water level is subtracted from the total depth, providing the length of the water column. This length is multiplied by the factor in the Table 7, which corresponds to the appropriate well diameter, providing the amount of water, in gallons, contained in the well.

WELL CASING DIAMETER vs. VOLUME (GALS.)/FEET of WATER	
CASING SIZE IN INCHES	GALLONS of WATER/FT
1	0.047
2	0.163
3	0.367
4	0.653
5	1.02
6	1.469

7	1.999
8	2.611
9	3.305
10	4.08
11	4.934
12	5.875

Table 9 Well Casing Diameter Vs. Well Volume

With respect to volume, an adequate purge is normally achieved when three to five times the volume of standing water in the well has been removed. Field parameter measurement may or may not be required, depending on the goals of the investigation. Any alternate purging techniques that isolate the stagnant water above the screen may not require the minimum of three well volumes to be removed. The field notes must reflect the single well volume calculations, according to one of the above methods, and a reference to the appropriate multiplication of that volume, i.e., a minimum three well volumes, clearly identified as a purge volume goal. Field notes must indicate measured parameters for each well volume when applicable.

When monitoring to the groundwater chemistry, an adequate purge is achieved when the pH, specific conductance, and temperature of the groundwater have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs). Stabilization occurs when pH measurements remain constant within 0.1 Standard Unit (SU), or reproducible to within 0.1 (SU), specific conductance varies no more that 10 percent, and the temperature are all-constant for at least three consecutive readings. There are no criteria establishing how many sets of measurements are adequate for the determination of stability. If the calculated purge volume is small, the measurements must be taken frequently to provide a sufficient number of measurements to evaluate stability. If the purge volume is large, an initial set of measurements must be taken and then one set for each well volume of water removed.

If, after three well volumes have been removed, the chemical parameters have not stabilized according to the above criteria, additional well volumes should be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project leader whether or not to collect a sample or to continue purging. The conditions of sampling must be noted in the field log. If a well has not purged to dryness, samples must be collected immediately after purging the well.

In some situations, even with slow purge rates, a well may be pumped or bailed dry (evacuated). In these situations, dryness generally constitutes an adequate purge and the well should be sampled immediately following sufficient recovery (enough volume to allow filling of all sample containers). For wells that are purged to dryness, it is not necessary that the well be evacuated three times before it is sampled. The pH, specific conductance, temperature, and turbidity must be measured, during collection of the sample from the recovered volume as the measurements of record for the sampling event. Alternatively, a slow purge sampling technique may be appropriate in this situation.

Attempts must always be made to avoid purging wells to dryness. This may be accomplished, for example, by slowing the purge rate. If a well is pumped dry, it may result in the sample being comprised partially of water contained in the sand pack, which may not yield a representative sample. In addition, as water re-enters a well that is in an evacuated condition, it may cascade down the sand pack or the well screen, stripping volatile organic constituents that may be present. This practice may also introduce soil fines into the water column.

Equipment Available

Monitoring well purging is accomplished by using in-place plumbing and dedicated pumps or, by using portable pumps/equipment/bailers when dedicated systems are not present. The equipment may consist of a variety of pumps, including peristaltic, large and small diameter turbine (electric submersible), bladder, centrifugal, gear-driven positive displacement or other appropriate pumps. The use of any of these pumps is usually a function of the depth of the well being sampled and the amount of water that is to be removed during purging and/or site specific conditions or chemistry. Whenever the head difference between the sampling location and the water level is less than the limit of suction and the volume to be removed is reasonably small, a peristaltic pump may be used for purging. Appendix I contains the operating instructions for all pumps commonly used during groundwater investigations.

The constituents of concern at each site and the sampling objectives will determine the type of materials and equipment that can be used for purging and sample collection. Each site must be looked at individually in order to determine the proper equipment that can be used.

4. Purging Techniques

Purging with Pumps

When peristaltic pumps or centrifugal pumps are used, only the intake line is placed into the water column. The line placed into the water should be either standard-cleaned (see Appendix H) appropriate tubing for peristaltic pumps or standard-cleaned appropriate pipe attached to a hose for centrifugal pumps.

When submersible pumps (bladder, turbine, displacement, etc.) are used, the pump itself is lowered into the water column. The pump must be cleaned as specified in Appendix H. Purging rates using pumps are dependent upon the rate of groundwater recovery in the well and the data quality objectives of the site. Wells must be purged at a rate that does not cause recharge water to be excessively agitated. If a particular zone within the screen is being monitored, there should be no drawdown, as other zones above the one being monitored could interfere with data results.

Purging with Bailers

Standard cleaned (Appendix H) bailers with new colorless nylon rope are slowly lowered into the top of the water column, allowed to fill, and slowly removed. It is critical that bailers be slowly and gently lowered into the top of the water column, particularly during final stages of purging, to minimize turbidity and disturbance of volatile organic constituents.

For the Department's purposes, a dedicated bailer is one dedicated to a single well at a single site and is: 1) marked as to the well to which it is dedicated; 2) decontaminated with laboratory-grade, phosphate-free detergent and rinsed with deionized water after use; and 3) wrapped in clean aluminum foil or plastic until the next sampling event. The bailer can be left hanging in the well, although it should not be left hanging in the water column, and the rope must be changed prior to use at the next sampling event.

Non-dedicated bailers must be decontaminated according to Appendix H from before placing into another well. The use of these types of bailers may require the collection of an equipment (rinsate) blank at each sampling event.

Disposable bailers are bailers that are used in only one well and then discarded after the samples have been collected at that well. These bailers should not normally be used on more than one well at more than one sampling event, as they are not constructed for multiple uses.

Field Care of Purging Equipment

Regardless of which method is used for purging, new plastic sheeting must be placed on the ground surface around the well casing to prevent contamination of the pumps, hoses, ropes, etc., in the event they need to be placed on the ground during the purging or they accidentally come into contact with the ground surface. Sample bottles, pH meters, conductivity meters, and associated field equipment must be placed on plastic to prevent contact with the ground surface. The sampler must not step on the plastic sheeting. It is preferable that hoses used in purging that come into contact with the groundwater be kept on a spool wrapped in plastic or contained in plastic or aluminum foil both during transporting and during field use.

Purging Entire Water Column

The pump/hose assembly or bailer used in purging must be lowered into the top of the standing water column and not deep into the column. This is done so that the purging will "pull" water from the formation into the screened area of the well and up through the casing so that the entire static volume can be removed. If the pump is placed deep into the water column, the water above the pump may not be removed, and the subsequent samples, particularly if collected with a bailer, may not be representative of the groundwater.

It is recommended that no more than three to five feet of hose be lowered into the water column. If the recovery rate of the well is faster than the pumping rate, and no observable draw down occurs, the pump should be raised until the intake is within one foot of the top of the water column for the duration of purging. If the pump rate exceeds the recovery rate of the well, the pump will have to be lowered, as needed, to accommodate the draw down. After the pump is removed from the well, all wetted portions of the hose and the pump should be cleaned as outlined in Appendix H.

Careful consideration shall be given to purging of wells with free phase material. When free phase material is encountered, purging is generally not recommended. Alternate sampling techniques must be utilized.

Low Flow/Low Volume Purging Techniques/Procedures

When performing low-flow/low stress purging, the device with the lowest water removal rate and the least tendency to stress the well during purging should be selected for use. Alternatives to the low flow purging procedures exist and may be acceptable. The low flow/low volume purging is a procedure used to minimize purge water volumes. The pump intake is placed within the screened interval at the zone of sampling. Low flow rate purging is conducted after hydraulic conditions within the well have re-stabilized, usually within 24 to 48 hours of pump installation. The rate of pumping from a well should not exceed the rate that the aquifer can recharge the well (i.e., the water level in the well should remain relatively constant). This is monitored by measuring the top of the water column with a water level recorder or similar device while pumping. Dissolved oxygen must also be measured as an additional indicator parameter until it has stabilized to within 10% over three consecutive measurements. These techniques, however, are only acceptable under certain hydraulic conditions and are not considered standard procedures.

No Purge

For wells meeting specific criteria, collecting a groundwater sampling without purging the well may be approved by the directing Program. Prior Program approval for collecting groundwater samples using no-purge methods is required. Analytical results from groundwater samples collected using a no-purge method may not be accepted if the method was not approved by the directing Program prior to sample collection.

Purging Techniques - Wells With In-Place Plumbing:

Wells with in-place plumbing are commonly found at municipal water treatment plants, industrial water supplies, private residences, etc. Many permanent monitoring wells at active facilities are also equipped with dedicated, in-place pumps. The objective of purging wells with in-place pumps is the same as with monitoring wells without in-place pumps, i.e., to ultimately collect a sample representative of the groundwater.

If the pump runs more or less continuously, no purge (other than opening a valve and allowing it to flush for a few minutes) is necessary. If a storage tank is present, a spigot, valve or other sampling point should be located between the pump and the storage tank. If not, the valve closest to the tank should be used. If the pump runs intermittently, it is necessary to estimate the volume to be purged, including storage/pressure tanks that are located prior to the sampling location. The pump must then be run continuously until the required volume has been purged. If construction characteristics are not known, best judgment should be used in establishing how long to run the pump prior to collecting the sample. Measurements of pH, specific conductance, temperature, and turbidity may be made and recorded at intervals during purging and sampling.

Purging Techniques - Temporary Monitoring Wells:

Temporary groundwater monitoring wells differ from permanent wells because temporary wells are installed in the groundwater for immediate sample acquisition. Wells of this type may include a standard well screen and riser placed in boreholes created by hand auguring, power auguring, or by drilling. They may also consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval.

As such, the efforts to remove several volumes of water to replace stagnant water, do not necessarily apply in these situations. It is important to note, however, that the longer a temporary well is in place and not sampled, the more appropriate it may be to apply standard permanent monitoring well purging criteria.
In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing aquifer conditions, resulting primarily in increased turbidity. Therefore, the goal of purging is to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity samples in these types of wells can be achieved by the use of low-flow purging and sampling techniques.

Low Flow Sampling of Temporary Monitoring Wells

In purging situations where the elevation of the top of the water column is no greater than approximately 25 feet below the pump head elevation, a peristaltic pump may be used to purge temporary wells. Enough tubing should be deployed to reach the bottom of the temporary well screen. At the onset of purging, the tubing should be slowly lowered to the bottom of the screen to remove any formation material that may have entered the well screen during installation. This is critical to ensure rapid achievement of low turbidity conditions. After the formation material is removed from the bottom of the screen, the tubing should be slowly raised through the water column to near the top of the column. The tubing must remain at this level to determine if the pump is lowering the water level in the well. If there is no drawdown, the tubing must be secured at the surface to maintain this pumping level.

If draw down is observed on initiation of pumping and a variable speed peristaltic pump is being used, the pump speed must be reduced to stabilize the draw down in the well, if possible. If the draw down stabilizes, the intake point and the pumping rate must be maintained. Sustained pumping at a low rate will usually result in a relatively clear, low turbidity sample. In situations where the draw down cannot be stabilized, the intake point must be continuously lowered to match the water column.

With many of the direct push sampling techniques, no purging is conducted. The sampling device is simply pushed to the desired depth and opened and the sample is collected and retrieved.

Purge Water Management:
Purge water is either discarded approximately 20 feet downgradient of the well or contained and managed as investigation derived waste, depending on contaminant levels in the water to be determined on a site specific basis.

5. Sampling

Sampling is the process of obtaining, containerizing, and preserving the groundwater sample. Samples must be collected immediately after the purging process is completed. In general, the order of well sampling should occur from the least to the most impacted well, if known. Unless specified in Appendix F, sample volumes will be determined by the analytical laboratory and will be listed in the QAPP addendum.

Sampling Techniques - Wells With In-Place Plumbing:
Samples must be collected following purging from a valve or cold water tap as near to the well as possible, preferably prior to any storage/pressure tanks that might be present. Hoses should be removed prior to sample collection. The flow should be reduced to a low level to minimize sample disturbance, particularly with respect to volatile organic constituents. Samples should be collected directly into the appropriate containers (see Appendix F).

Techniques - Wells Without Plumbing:
Immediately following purging, samples must be collected using the techniques which are described below. Samples collected for trace organic compounds must be collected at a rate slow enough to eliminate generation of excessive bubbles and aeration of the water as it enters the bottle.

Peristaltic Pump/Vacuum Jug

The peristaltic pump/vacuum jug can be used for sample collection because it allows for sample collection without the sample coming in contact with the pump tubing. This is accomplished by placing a transfer cap assembly onto the neck of a standard cleaned 4-liter (1 gallon) glass container. Tubing (3 inch OD) connects the container to both the pump and the sample source. The pump creates a vacuum in the container, thereby drawing the sample into the container without it coming into contact with the pump tubing.

Samples for volatile organic compound analysis must be collected using a bailer or by filling the tube, and allowing it to drain into the sample vials. The tubing can be momentarily attached to the pump to fill the tube with water. After the initial water is discharged through the pump head, the tubing is quickly removed from the pump and a gloved thumb placed on the tubing to stop the water from draining out. The tubing is then removed from the well and the water allowed to drain into the sample vials. Alternatively, the tubing can be lowered into the well to the desired depth and a gloved thumb placed over the end of the tubing. This method will capture the water contained in the tubing. It can then be removed from the well and the water collected by draining the contents of the tubing into the sample vials. Under no circumstances must the sample for volatile organic compound (VOC) analysis be collected from the content of any other previously filled container. Equipment must be cleaned using the procedures described in Appendix H.

Bladder Pumps

After purging has been accomplished with a bladder pump, the sample may be obtained directly from the pump discharge. The discharge rate of the pump must be minimized during sampling to diminish sampling disturbance. This is especially important for the collection of VOC and metals samples.

Bailers

When bailing, new plastic sheeting must be placed on the ground around each well to provide a clean working area. The colorless nylon rope must be attached to the bailer. The bailer must be gently immersed in the top of the water column until just filled. At this point, the bailer must be carefully removed and the contents emptied into the appropriate sample containers.

Diffusion Sampling

Diffusion sampling is a method of groundwater sampling for certain volatile organic compounds. No purging is required for this method of sampling. A water diffusion sampler consists of a diffusible bag, like polyethylene, filled with deionized water and sealed. Commercially available samplers should be used when possible. Proper QA/QC on the quality of the deionized water needs to be obtained in order to adequately interpret sample results. The bag must be positioned within the screened interval of the well by hanging the bag from a nylon or stainless steel cord attached to the top of the well. The diffusion bag sampler needs to remain in the well until concentrations within the bag reach equilibrium with those in the surrounding groundwater. Typically after a period of two weeks the bag can be withdrawn from the well, emptied into a standard sampling container (e.g., a VOA vial), sealed and shipped for analysis.
Diffusion samplers may also be used to collect samples from the groundwater/surface water interface or transition zone. The sampler is emplaced (buried) within the transition zone and allowed to equilibrate for a period of two weeks. The sampler is then removed and water is withdrawn from the bag for analysis.

Direct Push Sampling

Direct push sampling may be used when an investigation centers around constituents that are not affected by sample turbidity. Direct push sampling is not generally recommended for metals or PCBs. The direct push unit allows a microscreen to be opened at various intervals to the formation of interest. Methods of water sample collection using direct push technology employ either a vacuum pump or an inert gas lift system. The inert gas lift system reduces the chance for volatilization of constituents from the sample. Sampling occurs from the chamber within the screen (gas lift) or from tubing attached to the screen (vacuum lift). All direct push well screens must be cleaned in accordance with the decontamination procedures presented in Appendix H between sample locations and before usage. For vacuum pump sampling, new tubing must be used at each sample location.

No-Purge Sampling for Petroleum Releases

For wells meeting specific criteria, collecting a groundwater sampling using standard sample collection methods without purging the well may be approved by the directing Program. Prior Departmental Program approval for collecting groundwater samples using no-purge methods is required. Analytical results from groundwater samples collected using a no-purge method may not be accepted as reliable by the Department if the method was not approved by the directing Program prior to sample collection.
Wells that may be approved for no-purge sampling must meet the following criteria.

- The water level in the well is within the screened interval;
- The primary chemicals of concern are petroleum chemicals;
- There is no non-aqueous phase liquid present; and,
- The well has been previously sampled within the past 12 months.

Petroleum chemicals are predominantly volatile organic compounds. Therefore, sample collection shall be in accordance with methods described above for bailers, bladder pumps, or diffusion sampling rather than methods that apply a vacuum to the sample. Prior to sample collection, the water level must be gauged and recorded to ensure that it is within the screened interval and no free-phase product exists. Indicator parameters to be measured in the field should be measured after sample collection.

Sample Preservation

Immediately after collection, all samples requiring preservation must be preserved with the appropriate preservative, unless the laboratory has already placed the preservative in the sample bottles. Consult Appendix F for the correct preservative for the particular analytes of interest. All samples preserved using a pH adjustment (except VOCs) must be checked, using pH strips, to ensure that they were adequately preserved. This is done by pouring a small volume of sample over the strip. Do not place the strip in the sample. Those samples requiring cooling must be placed on ice immediately after collection.

6. Special Sample Collection Procedures

Volatile Organic Compounds and Metals

In most cases, samples collected for organic compounds and metals must be collected prior to other samples, with VOC samples being collected first. The VOC samples must be collected so that no air bubbles remain in the sample container. These samples must be collected by slowly pouring the sample contents into the vial until a convex meniscus is seen on the surface of the vial. A Teflon lined septum cap must carefully be placed on the vial until finger tight. The sample bottle should then be inverted to verify that no air bubbles have been trapped inside.

Filtering

As a general rule, groundwater samples should not be filtered. However, filtration may be needed to correct for chronically turbid wells. Filtered samples must not be collected from usable water supply wells. Filtering is also not recommended when the sample turbidity appears to be chemically-induced or colloidal.
When samples are filtered, such as under conditions of excessive turbidity, both filtered and unfiltered samples must be submitted for analyses. Samples for organic compounds analysis must not be filtered. It is recommended that efforts be undertaken to minimize any persistent sample turbidity problems. These efforts may consist of the following:

- Implementation of low flow/low stress purging and sampling techniques.

- Redevelopment of permanent ground water monitoring wells.

Specific Sampling Equipment Quality Assurance Techniques:
All equipment used to collect groundwater samples shall be cleaned as outlined in Appendix B and repaired, if necessary, before being stored at the conclusion of field studies. Cleaning procedures utilized in the field (Appendix H), or field repairs shall be thoroughly documented in field records.

Field Documentation:
During groundwater sample collection, it is important to record a variety of groundwater related including water level well volume, pumping rates, turbidity and perhaps well logs. This information must be documented in the field records. Well volume determinations are described in the Groundwater Sampling Section C. If indicator parameters such as pH, conductivity, and temperature are used during well purging and sampling, the data must be recorded in the field notebook, along with the time of the measurement and the associated well volume. Indicator parameter measurements (pH, conductivity, etc.), including time measurements/volume of water pumped, must be recorded in the field notebook.

Miscellaneous information that must be included in the field notes include, but is not limited to, the weather conditions, type of equipment used for purging and sampling, time of sample collection, and any problems with the monitoring well casing, pad, lock and other problems at the location of the well such as overgrown vegetation.

B3 Sample Handling & Custody

See Appendix F for Preservation and Holding Times for laboratory analyses. All field analyses must be done within 15 minutes of sample collection.

Chain of Custody Forms must contain, at minimum, the following information:

1. Collection date and time for each sample. If the sample is a composite sample and is collected by an automatic sampler, the starting and ending dates and times of the sampling period must be documented. If the composite sample was collected manually, the date, time, and collector of each portion must be documented also.
2. Printed name and Signature of sample collector(s).
3. Unique sample identification number (see below). One sample should be entered on each line or column and a sample should not be split among multiple lines or columns.
4. Sampling location and description (if necessary).
5. Sample type - grab or composite. Although grab and composite samples might be collected from the same location at the same time, they differ in composition and must be listed separately and must have unique identification numbers.
6. Analyses required, specified for each sample.
7. Preservatives used (H_2SO_4, NaOH, ice, etc.) for each sample. This includes any dechlorination agents or other chemicals added to the bottle prior to sampling.
8. Program area – This must be listed as UST Management Division.
9. Sample matrix – drinking water, groundwater, waste, soil, free product, etc.
10. Transfer signatures with dates and times for both relinquishment and laboratory receipt (the laboratory should indicate courier, FEDEX, UPS, etc. in the "relinquished to" space if applicable).
11. Receipts maintained when shipped by common carrier (FEDEX, UPS, etc.). These receipts should be attached to the pertinent chain-of-custody records.
12. The number and type of container used.

Monitoring wells should be designated with the 5-digit permit number and the well id (e.g. 12345-MW1). Water supply wells should be designated with the 5-digit permit number and the well Id (e.g. 12345-WSW1). Surface water sampling locations should be designated with the 5-digit permit number and the location ID (e.g. 12345-SW1). Soil borings should be designated with the 5-digit permit number and the location ID (e.g. 12345-SB1).

Samples shipped to laboratories must be received below 6°C but above 0°C (unless analytical method requires lower temperature). Temperature blanks may be used. Their purpose is to determine the internal temperature of the shipping container upon arrival at the lab. Blanks should consist of one or more small containers (40-250 ml) of water placed in the ice chest with samples and marked as a "Temperature Blank". Alternative methods for measuring temperature, such as an infrared thermometer, may also be used. The temperature at receipt (arrival) must be documented on the chain of custody form. Temperature blank or cooler environment must be documented; sample container should not be used.

In the QAPP Addendum the Contractor must give specific information on how the samples will be shipped to the laboratory, indicating how sample or information handling and custody information should be documented, such as in field notebooks and forms, and identifying the individual responsible for this. (See Appendix_B)

B4 Analytical Methods

Analytical procedures for field measurable physical and chemical characteristics as well as performance criteria are found in Appendix E.

The contractor will identify which methods the lab will be using in the QAPP Addendum.

Maximum Turnaround time is 3 weeks.

The QAPP Addendums will include sample disposal information and corrective actions for analytical failures. However, when analytical failures occur, the UST Project Manager must be contacted within 24 hours.

If Ferrous Iron or the Kerr method (non-standard methods) is employed, the Addendum will include an attached SOP.

The analytical laboratory is responsible for necessary corrective action related to analytical methods.

B5 Quality Control Requirements

Because of the role laboratory data plays in determining regulatory courses of action and decision-making, a QA/QC program to ensure data reliability and quality data is essential. Sample collection, preservation, handling and storage, as well as each step in the analytical method, are considered as they relate to precision, accuracy and the stated data quality needs for a given project. Please refer to Appendix E for the field and laboratory quality control requirements.

In the case of QC failure, the sample must be reanalyzed. In the event that additional sample in not available or cannot be recollected, the contractor must notify the UST Project Manager within 24 hours. The contractor is responsible for necessary corrective action.

Trip blanks will be submitted for each sampling event. The blanks are prepared by the analyzing laboratory using distilled or de-ionized water that is analyte-free and which is shipped with the other sample bottles to the field and then returned to the analyzing laboratory with the samples for analysis. The trip blanks are not separated from other samples. They must be packaged with the environmental samples collected during the sampling event. They are collected to check sample contamination from on-site conditions. One trip blank will be included in each sample cooler. The trip blank must be analyzed for VOCs.

Field blanks will be collected for each site survey. Field blanks for VOCs and metals must be collected using the same sample collection procedures. Field blanks are used to assess potential contamination of samples from the site environment.

Field duplicates will be collected. One duplicate will be collected for every batch of twenty samples or less. Field duplicate samples are taken within five minutes of collecting the original samples and include all the sub-samples. A new sample is collected from the sampling point for the field duplicate. The samples are shipped back with the other sample bottles for analysis. The precision resulting from field duplicates is a function of the variance of sample composition, the variance of the sampling technique, and the variance of laboratory sample. One duplicate sample will be collected for each twenty samples, or subset thereof.

Laboratory QA/QC information for all sample sets will be required and reviewed by staff. This should include matrix spikes and duplicates in the analytical batch that are non-DHEC project samples. All laboratories must also meet all quality control procedures outlined in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846. Corrective action procedures used by the laboratories are discussed in each laboratory's QA Plan. Precision and accuracy will vary with the analytical method and laboratory procedures. The analyzing laboratory must make precision and accuracy statements available upon request. The analyzing laboratory must prepare a quality assurance report evaluating the quality control measurements listed above.

An analytical laboratory certified for required parameters through the SCDHEC's Office of Environmental Laboratory Certification program must perform all analytical methods.

Formulas for calculating QC statistics are in Section A7. If the Contractor is using other procedures, then these must be given in the QAPP Addendum.

B6 Instrument/Equipment Testing, Inspection, and Maintenance

Laboratory and field instrumentation will be tested daily prior to use. Specific information about what equipment must be tested, inspected, maintained, spare parts and their location will be required in any addendum to the QAPP provided by the contractors. Corrective action information is also required in the QAPP Addendums.

All equipment shall be routinely inspected and maintained according to the service and instruction manuals. Maintenance documentation for the equipment must be kept on file and made available upon request. All instruments and equipment will be tested, inspected, and maintained according to the manufacturer's guidelines and recommendations. Project staff that have been properly trained in these procedures will operate the instruments.

All disposable sampling equipment is used one time, then properly containerized and disposed of. Reusable sampling and investigative equipment is decontaminated prior to commencement of an investigation or sampling event and is decontaminated between uses and at the end of the event.

Field decontamination methods are detailed in Appendix H.

B7 Instrument/Equipment Calibration and Frequency

All field equipment needed for sampling, as well as safety equipment, will be calibrated prior to and during continued use to assure that all measurements are as accurate as possible. Personnel will follow the manufacturer's instructions to determine if the instruments are functioning within their established operation ranges. The calibration will be recorded in the field logbook as well as the field data sheet. The field analyst will specify the identification of the field instrument by serial number in the field logbook as well as the field data sheet so that the calibrations are traceable to a specific piece of equipment. Instrument specific calibration standard requirements or ranges for performing the initial calibration or end-of-day check will be listed in the QAPP addendum.

To be acceptable, a field test must be bracketed between acceptable calibration results.

1. The first check may be an initial calibration, but the second check must be a continuing verification check.

2. Each field instrument must be calibrated prior to use.

3. Verify the calibration at the beginning of each work shift, during use, and at the end of the use.

4. All initial calibration and verification checks must meet the acceptance criteria in the table below.

5. If an initial calibration or verification check fails to meet the acceptance criteria, immediately recalibrate the instrument or remove it from service.

6. If a verification check fails to meet the acceptance criteria and it is not possible to reanalyze the samples, the following actions must be taken:

    a. Report all results between the last acceptable verification check and the failed check as 'estimated' (qualified with a "J");
    b. Include a narrative of the problem; and
    c. Shorten the time period or frequency between verification checks or repair/replace the instrument.

7. All acceptable field data must be bracketed by acceptable checks or the data must be qualified.

Field Parameter	Acceptance Criteria
Temperature	±1°C against an NIST-traceable thermometer
Specific Conductance	10% of each standard used
pH	±0.1 pH units of stated buffer value
Turbidity	10% of each standard used

Table 10 Field Parameter Acceptance Criteria

Any sampling equipment or field measurement instrument determined to be malfunctioning in any way must be repaired and recalibrated or removed from service. This corrective action must be documented in the records.

Laboratory equipment calibration protocols are addressed within SOPs that are reviewed by the Office of Environmental Laboratory Certification. Laboratory equipment will have a calibration log book for each piece of instrument that will be maintained by the analyst.

B8 Inspection/Acceptance of Supplies and Consumables

The following applies to UST Management Division staff:

The necessary supplies for field sampling include polyethylene bailers, nitrile gloves, calibration standards for pH, conductivity, and turbidity, sterile glass or plastic sample containers with labels, insulated containers for transporting samples, ice, water quality sampling forms, and sampling SOPs/checklists. The UST Management Division's Senior Field Technician and Laboratory Contract Manager are responsible for ensuring that necessary field and sampling supplies are available as needed.

The analyzing laboratory shall have written procedures for inspecting and accepting supplies and consumables. The analyzing laboratory will provide documentation of the integrity of the sample containers prior to receipt by the UST Management Division. Bailers shall have written quality assurance certification provided Acceptability requirements for non-analytical supplies and consumables are provided in the table below.

Supplies and consumables are inspected upon receipt for breakage and intact packaging. All supplies are re-inspected prior to usage in the field. To prevent tampering, supplies and consumables are stored in the supply storage room that can be locked when staff is not in attendance.

The following applies to the contractors:
Contractors will provide a list in the QAPP addendum concerning items for field sampling and the analyzing laboratory shall have written procedures for inspecting and accepting supplies and consumables. The analyzing laboratory will provide documentation of the integrity of the sample containers. Supplies and consumables for field and laboratory analysis are inspected as part of a contractors standard operating procedures. The contractor shall maintain documentation of the acceptability of all analytical consumables.

Item	Vendor	Acceptance criteria	Handling/Storage Conditions	Person responsible for inspection and tracking.
Nitrile gloves	All	No holes; must be nitrile NOT latex	1 box of appropriate size per vehicle; also used in lab	UST Staff, Contractor, or laboratory staff
Bailers	All	Polyethylene	1 box of appropriate size per vehicle	UST Staff or Contractor
Calibration standards for pH, conductivity, and turbidity	All	Must be within expiration data and acceptable for the allowable method.	Office prep area-room temperature	UST Staff or Contractor
Insulated containers	All	Used only for sample transportation, in good condition, no damage that would compromise sample integrity	Office prep area-room temperature	UST Staff, Contractor, or laboratory staff

Table 11 List of Consumables and Acceptance Criteria

B9 Non-direct Measurements

The UST Management Division utilizes data from non-measurement sources to populate risk or groundwater fate and transport models when values derived from direct measurement do not exist or cannot be readily obtained. These data are gathered from sources such as EPA standards and from published scientific papers. These data sources are known to be acceptable and are used throughout the country. As these data are not site-specific, values used are conservative in order to produce results that are protective of human health and the environment. Site-specific values will be used whenever possible.

The contractor will be required to list the data source and provide a reason for use in the QAPP addendum.

B10 Data Management

Note: The Contractor will be responsible for providing the Project Specific data management scheme and the specifics of data archival for both the contractor and the lab that is used.

1. Field Data

All field data and observations will be recorded and maintained by the contractor. After field data has been reviewed for accuracy, it will be produced in tabular form for inclusion in the final report.

Any problems encountered through direct observation or through review of field data will be identified to the DHEC Project Manager and documented in the final report. The report shall include documentation of any corrective measures taken and discussion of any potential effect on field data objectives.

2. Laboratory Data

Prior to release of the analytical report, the sample data will be reviewed by the laboratory for accuracy, precision, and holding times. This process shall include a review of the data by the primary analyst and than a final review by the laboratory's Quality Control Officer. The data will be reported on a dry weight basis and take into account any required dilutions. The analytical data packages will include the following information: sample ID, analyst's initials, sample results, method blank results, laboratory control sample recovery, matrix spike/matrix spike duplicate recoveries and relative percent differences, surrogate recoveries, date and time of sample collection, date and time of sample receipt, date and time of sample preparation, date and time of sample analysis, dilution factors, pH of water samples, sample temperature at time of receipt, analytical and preparation methods used, method detection and quantitation limits, problems and corrective action, and applicable certifications. (See also Section A9).

The laboratory's review of the data will be based on the following criteria:
All analytical holding times are met,
Use of specified analytical procedures,
Use of properly calibrated and operating instruments,
Successful analysis of the appropriate QC samples.

Once samples have been collected and analyzed, the project manager will assess the data for completeness and data entry errors. Any discrepancies will be verified with the hard copy, the sampler, and the analytical laboratory. The nature of the data and the subsequent analyses will be consistent to permit the comparison of data in one set to others.

3. National Data

The UST Management Division provides data to EPA Region 4 on a quarterly basis using the EPA Region 4 Underground Storage Tank Section Quarterly Activities Report.

4. Data Storage

Hard copies of field and laboratory data will be stored in accordance with the UST Management Division's Records Retention Schedule. (See Appendix J) Worst-case results will be entered into the Environmental Facility Information System (EFIS) database. The UST Management Division is scanning all received documents and storing electronically. The Electronic data will be stored for the life of the system.

The contractor and laboratories will be required to maintain a copy of all information submitted to the UST Management Division for a minimum of five years, unless otherwise specified.

Currently the UST Management Division is accepting data in hardcopy format from the contractor. In the near future, the UST Management Division will accept data in electronic format to be submitted for electronic validation.

The UST Management Division is scanning all received documents and storing electronically.

Refer to Section 9 of the SCDHEC EQC and OCRM Quality Management Plan, 2008 (See Appendix_L) for details describing procedures for demonstrating the acceptability of the hardware and software configurations for the UST Management Division. Contractor procedures should be comparable especially in that their procedures must follow Federal and State Mandates. In addition, all software should be demonstrated to be acceptable for UST projects PRIOR to use.

SECTION C ASSESSMENT AND OVERSIGHT

C1 Assessment and Response Actions

Types of Assessments

- On-site Field Audit (OFA) - A thorough on-site audit during which sampling design, equipment, instrumentation, supplies, personnel, training, sampling procedures, chain of custody, sample handling and tracking, data reporting, data handling and management, data tracking and control, and data review procedures are examined for conformance with the QAPP. An OFA may be scheduled at the discretion of the DHEC Project Manager or the Contractor.

- On-Site Analytical TSA (Lab Certification Audit)- An on-site audit of analytical procedures during which the facility, equipment instrumentation, supplies, personnel, training, analytical methods and procedures, laboratory procedures, sample handling and tracking, data reporting, data handling and management, data tracking and control, and data review procedures are checked for conformance with the QAPP. This can be performed at any time during the project. The SCDHEC Office of Environmental Laboratory Certification requires at least one on-site analytical TSA every three years for certification purposes. This on-site audit includes a data audit as well. Auditors from SCDHEC Office of Environmental Laboratory Certification are drinking water laboratory certification officers certified by EPA Cincinnati. The job requirements for an auditor include a science degree and extensive laboratory experience. At the end of the on-site audits, a closeout meeting is held with laboratory personnel and management to list the deficiencies found during the on-site inspection. Within 6 weeks an audit report is sent to the lab manager detailing what seen during actual audit but also deficiencies found in records and data. The laboratory has one month to report corrective action they are taking to correct the deficiencies. Responses to audits go directly to the Office of Environmental Laboratory Certification, the certifying authority for the laboratory certification program at SCDHEC.

- Subcontracted Laboratory Record/Data Audit - An off-site audit of a subcontracted lab to determine that said lab is certified by DHEC for all analytes to be reported. The Contractor or Project Manager can also request training records, analytical records and procedures, laboratory procedures, sample handling and tracking, data reporting, data handling and management, data tracking and control, and data review procedures to be checked for conformance with the QAPP. The need for this audit is determined by Project Manager or the Contractor. This type of audit is performed when the primary lab has subcontracted part of the project work. <u>This can be performed at any time during the project. In addition, the laboratory certification status must be determined prior to any samples being analyzed.</u>

- Split Sampling and Analysis Audit - A comparison study to assess laboratory precision and accuracy. The sampler collects one field sample and then physically splits it into two representative sample aliquots. <u>For split samples to be truly comparable the splits must have identical sample handling and pretreatment, the laboratory(ies) must use the same analytical methods, and the QC items for the analytical runs must be the same.</u> Split samples quantitatively assess the measurement error introduced by the organization’s sample shipment and analysis system and must be accompanied by a PT Sample to establish the acceptance criteria. Split sample comparability criteria must be generated prior to sample collection and documented in the QAPP.

- Proficiency Test (PT) Sample Tracking and Analysis- Providers of testing materials must be acceptable to the Office of Environmental Laboratory Certification. Successful annual analysis of PTs is required to maintain certification.

Assessment E or I	Frequency	Organization Responsible	Individual Receives Report & Notification of Deficiencies	Time-frame of Notification	Individual that Implements Corrective Actions?	Corrective Action Effectiveness Documented where?	Individuals Receiving Corrective Action Response
PT /E	One per year	PT Provider acceptable to SCDHEC Office of Environmental Laboratory Certification	**Field:** Field Manager or Contractor **Lab:** Laboratory QC Officer and/or Lab Director **SCDHEC:** Office of Environmental Laboratory Certification	Approx. 3 weeks after study ends	**Field:** Field Manager or Contractor **Lab:** Laboratory QC Officer	Memo to Lab QA Officer or Contractor	Lab QA Officer or Contractor and possibly the Lab Director
TSA/E – (Lab Cert Audit)	Per SCDHEC Office of Environmental Laboratory Certification's policy.	SCDHEC	Lab QA Officer and Lab Director	Per SCDHEC Office of Environmental Laboratory Certification's policy.	Lab Director	Response to Audit	Director, SCDHEC Office of Environmental Laboratory Certification
Onsite Field Audit	As dertermined by the UST Project Manager	Contractor	UST Project Manager	2 days	Contactor	Final report to submitted to SCDHEC	UST Management Division personnel
Onsite TSA/I For Analytical Lab	As determined for the specific project by UST Staff.	Lab QA Office but requested	Lab Manager and UST Project Manager	2 weeks	Lab Manager	Response to Audit	UST Project Manager and Lab QA Manager
Subcontract Laboratory Record/Data Audit	As determined for the specific project by UST Staff . For subcontracted Labs to determine compliance to the QAPP and certification status.	Contractor or UST Project Manager	Laboratory Director and SCDHEC UST Project Manager. If initiated by the UST Project Manager, the Contractor will get a copy of the report.	1 week	Lab Director	Email to Contractor or UST Project Manager. If Cert. Status is an issue an updated Lab. Cert. Certificate must be included.	Contractor and SCDHEC UST Project Manager
Split Sampling	As determined for the specific project by the UST Project Manager	Contractor	Lab Director and UST Management Division Project Manager	4 weeks after sample collection (turn around time for the Labs is 3 weeks)	Contractor with the Lab Director	Email to UST	UST Project Manager

C2 Reports to Management

The UST Management Division will submit the QAPP to the EPA for approval and when changes are made to the QAPP. The SCDHEC UST Program is an approved program by EPA. As such, specific site reports are not submitted to EPA.

The contractor will provide the UST Project Manager with a Project Status Report (see Appendix M) on a weekly basis via e-mail. The Status Report will include the UST Permit number, facility name, date of update, current status, any issues that have arisen, corrective action measures taken to correct deficiencies, any changes to date final report is to be submitted. Due to the nature of the work conducted by the contractors and the UST Management Division, the contractor will notify the UST Management Division project manager within 24 hours via phone or e-mail concerning any quality assurance problems. This is important because the project manager and the contractor will determine appropriate corrective action measures to be taken. The environmental contractors and analytical laboratories shall be responsible for reporting and correcting all sample handling procedures that deviate from the approved Data Quality Objectives and/or other project specific requirements. The UST Project Manager will be informed of these issues via the weekly Project Status Report. The UST Project Manager will be notified within 24 hours via phone or e-mail of any issue that cannot be satisfactorily resolved between the contractor and analytical laboratory to determine the appropriate corrective action measures to be taken. A discussion of the problem(s) encountered, including quality assurance problem, the actions taken, and the results will be included in the final report submitted to the UST Management Division. A compilation of the weekly status reports will be included in the final report submitted to the UST Management Division

The UST Project Manager has the discretion of conducting onsite visits to assess the performance of the contractor in accordance with the QAPP. The results will include the finding of the visit, any discrepancies, corrective action measure taken, and results of any follow-up visits. The results of the onsite visit will be documented and stored with the project file.

The UST Project Manager assesses data submitted by the contractor, in cases where errors compromise the integrity of the project, UST Program management is notified.

SECTION D DATA VALIDATION AND USABILITY

D1 Data Review, Verification and Validation

To ensure that data generated are of appropriate quality, all data will be verified and validated. These are systematic procedures for reviewing a body of data against a set of established criteria to provide a specified level of assurance of its validity prior to its intended use. The techniques used must be applied to the body of the data in a systematic and uniform manner. The process of data validation must be close to the origin of the data, independent of data production, and objective in its approach. All data, as applicable, will be validated in accordance with EPA guidance, per Data Quality Objectives Process. Any deviations will be documented and provided with the final report.

If verification or validation indicates that samples have been collected and/or analyzed out of compliance with the QAPP (for instance deviations from the acceptance criteria for quality control defined in this QAPP and its addendums), resampling may be required.

The contractor must contact the UST project manager in the event that there are any deviations from the QAPP and the UST project manager will determine if the data is acceptable or if resampling is required. If data is accepted that deviates from the QAPP, the data will be used for screening purposes only and the data will be annotated as such.

If a laboratory is found to have lost certification for any of the performed analysis, the data will be used for informational purposes only and annotated as such.

The contractor's laboratory will provide a list of data qualifier flags and definition for each in the QAPP Addendum.

D2 Data Validation and Verification Methods

The objective of this section is to describe how data is reviewed. It has been noted that the Analytical Laboratories have internal review systems in place to verify the data before it leaves the lab.

Verification of the sample data is done by the laboratory. Verification of the entire project including the data is performed by the Contractor's Office. A checklist is used by the Contractor (see Appendix K) to ensure that this is a thorough check on not only the completeness of the data but adherence to the QAPP. The contractor will include this checklist as part of the final report so that validation can be done. The list will include any anomalies noted in the field notes, the data, or the sample narrative from the laboratory. All deviations from the acceptable criteria and potential impacts affecting the usability of the data shall be reported by the data supplier.

UST Management Division staff will validate the analytical and project data supplied to ensure compliance with the formal and/or informal Data Quality Objectives stated in all approved work plans, permit provisions, enforcement order provisions, and the applicable federal and/or state guidance documents. Validation of the data by the Project Manager shall include a check on

1. Completeness of the data;
2. Adherence to proper sample preservation, transport, or handling protocols;
3. Proper use of sample collection procedures;
4. Proper use of quality control criteria;
5. Documentation of all data;
6. Ability to reconstruct all field sampling procedures through documentation and records of such procedures;
7. Ability to trace data in the final report to a specific sampling site, date, and time;
8. Appropriateness of the data as related to specific data quality objectives.

Upon receiving the final report the UST project manager will validate the project data by first reading the report and reviewing the checklist, noting the anomalies listed as well as those seen in the report. Then the

Project Manager will determine that all the wells were sampled or that a reason was given why a well was not sampled. Chain of custody (COC) for samples is examined to ensure that it is properly completed and documented the condition of samples during their preparation, packing, transportation, and analyses. The environmental contractors and analytical laboratories shall be responsible for reporting and correcting all sample handling procedures that deviate from the approved Data Quality Objectives and/or other project specific requirements. The time the sample was collected until it was received by the laboratory is checked for consistency---and for time travel (meaning the sample was received before it was collected or other inconsistencies). The temperature upon receipt is also checked. The Validator will also determine if the Lab was certified throughout the study.

The lab reports are examined to make sure that all required analytes are present and were analyzed according to the requirements of the QAPP. The data is further examined against historical data to note changes and anomalies. If data anomalies become a concern and cannot be explained, SCDHEC may arrange for an independent verification by resampling or refer to the Regulatory Section of UST for an investigation of a potential subsequent release. QC data is examined for completeness and adherence to the requirements of the QAPP. This examination includes an examination to ensure that necessary corrective actions have been taken when QC does not meet QAPP or method requirements. The contractor is responsible for ensuring that the QC requirements have been met and is not supposed to submit a report until this has been done. This review by the Project Manager serves as a second check.

Validation is also done on the well construction and boring logs. The records are reviewed for completeness and anomalies. Certification of the well driller is checked. The field measurements are examined to ensure that the wells were purged in accordance with the QAPP. Lastly, the Disposal Manifest is checked to ensure that the contractor has included this in the report.

Any anomalies or items that do not meet the requirements of the QAPP are noted in a Verification, Validation and Usability Report. This is generated by the Project Manager and is based on his findings during the validation, but can include items from the Contractors verification process as well as conferences with the contractor concerning problems and the corrective action to those problems. This Report is scanned in and associated with the electronic version of the Contractor's final report.

	Activity
Data Deliverables and QAPP	Ensure that all required information on sampling and analysis was provided (including planning documents).
Analytes	Ensure that required lists of analytes were reported as specified.
Chain-of-Custody	Examine the traceability of the data from time of sample collection until reporting of data. Examine chain-of-custody records against contract, method, or procedural requirements.
Holding Times	Identify holding time criteria, and either confirm that they were met or document any deviations. Ensure that samples were analyzed within holding times specified in method, procedure, or contract requirements. If holding times were not met, confirm that deviations were documented, that appropriate notifications were made (consistent with procedural requirements), and that approval to proceed was received prior to analysis.
Sample Handling	Ensure that required sample handling, receipt, and storage procedures were followed, and that any deviations were documented.
Sampling Methods and Procedures	Establish that required sampling methods were used and that any deviations were noted. Ensure that the sampling procedures and field measurements met performance criteria and that any deviations were documented.
Analytical Methods and	Establish that required analytical methods were used and that any deviations were noted. Ensure

Procedures	that the QC samples met performance criteria and that any deviations were documented.
Data Qualifiers	Determine that the laboratory data qualifiers were defined and applied as specified in methods, procedures, or contracts.
Deviations	Determine the impacts of any deviations from sampling or analytical methods and SOPs. Consider the effectiveness and appropriateness of any corrective action.
Sampling Plan	Determine whether the sampling plan was executed as specified (i.e., the number, location, and type of field samples were collected and analyzed as specified in the QAPP).
Sampling Procedures	Evaluate whether sampling procedures were followed with respect to equipment and proper sampling support (e.g., techniques, equipment, decontamination, volume, temperature, preservatives, etc.).
Co-located Field Duplicates	Compare results of collocated field duplicates with criteria established in the QAPP.
Project Quantitation Limits	Determine that quantitation limits were achieved, as outlined in the QAPP and that the laboratory successfully analyzed a standard at the QL.
Confirmatory Analyses	Evaluate agreement of laboratory results.
Performance Criteria	Evaluate QC data against project-specific performance criteria in the QAPP (i.e., evaluate quality parameters beyond those outlined in the methods).
Data Qualifiers	Determine that the data qualifiers applied were those specified in the QAPP and that any deviations from specifications were justified.
Validation Report	Summarize deviations from methods, procedures, or contracts. Include qualified data and explanation of all data qualifiers.

Table 12 Validation Activities

D3 Reconciliation with User Requirements

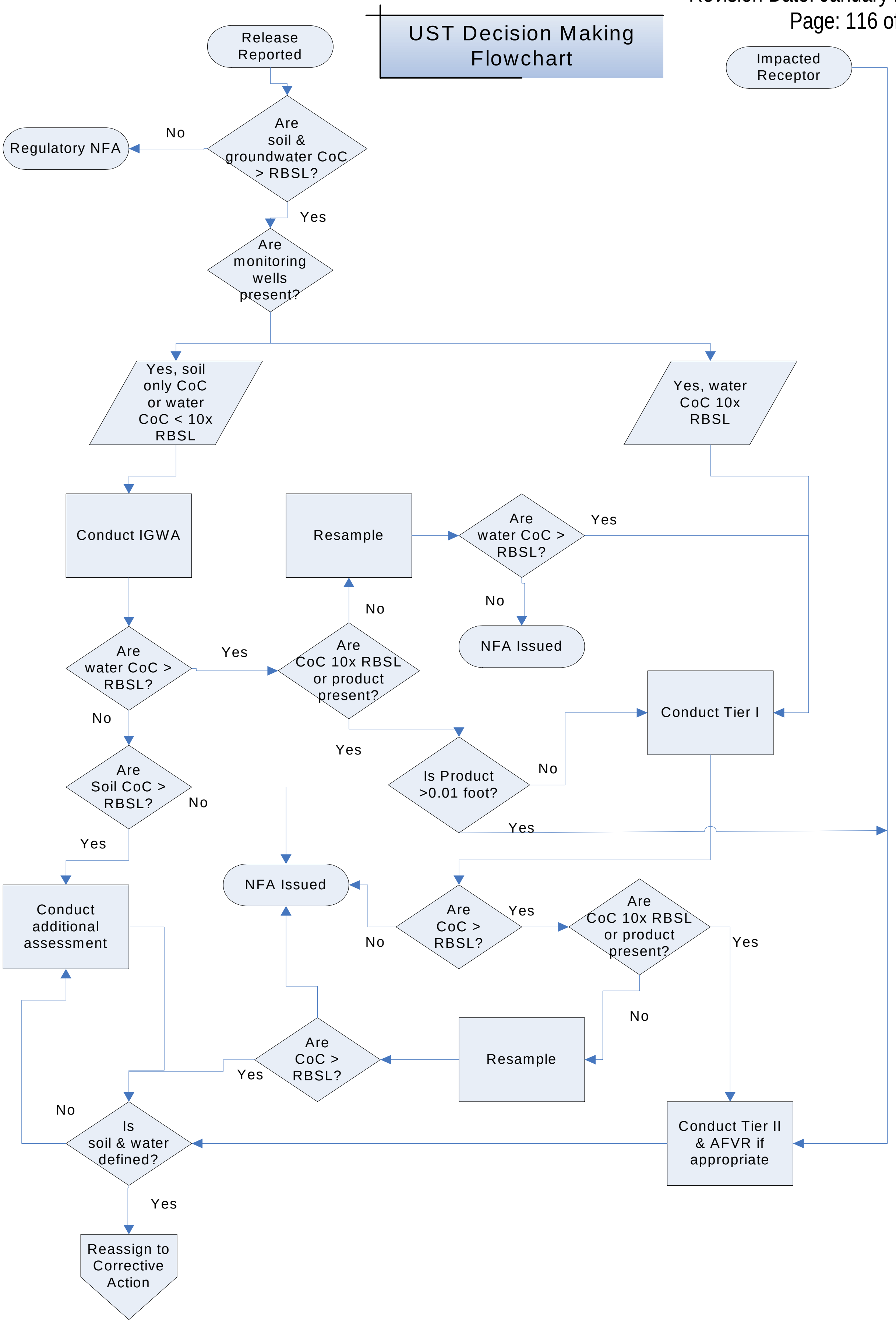
The project manager shall ensure that the data collected address the needs to evaluate the UST site and meet the specific Data Quality Objectives specified previously. This is done in conjunction with data verification and validation. The Usability Report will be part of the Verification, Validation and Usability report discussed in Section D2. This will document problems and corrective action throughout the project and discuss findings in the data and report that appear to be anomalous, but do not significantly impact the usability of data as a whole. Because data generated with significant deviations from the requirements of the QAPP will be rejected and because of the nature of the work (biased sampling), all data will have the same expected uncertainties and there will be no limitations on data use.

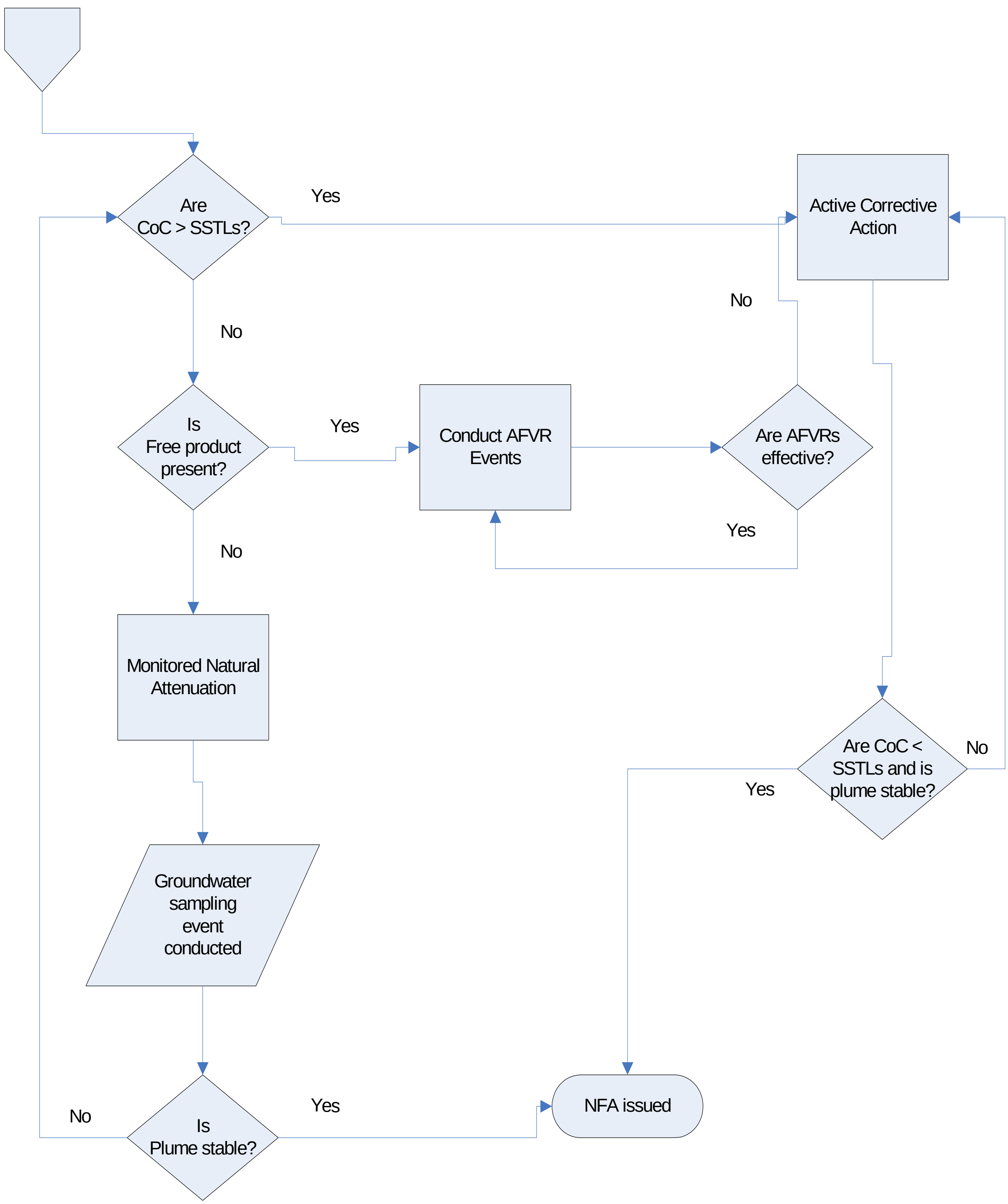
Item	Assessment Activity
Data Deliverables and QAPP	Ensure that all necessary information was provided, including but not limited to validation results.
Deviations	Determine the impact of deviations on the usability of data.
Sampling Locations, Deviation	Determine if alterations to sample locations continue to satisfy the project objectives.
Chain-of-Custody, Deviation	Establish that any problems with documentation or custody procedures do not prevent the data from being used for the intended purpose.
Holding Times, Deviation	Determine the acceptability of data where holding times were exceeded.
Damaged Samples, Deviation	Determine whether the data from damaged samples are usable. If the data cannot be used, determine whether resampling is necessary.
PT Sample Results, Deviation	Determine the implications of any unacceptable analytes (as identified by the PT sample results) on the usability of the analytical results. Describe any limitations on the data.

SOPs and Methods, Deviation	Evaluate the impact of deviations from SOPs and specified methods on data quality.
QC Samples	Evaluate the implications of unacceptable QC sample results on the data usability for the associated samples. For example, consider the effects of observed blank contamination.
Matrix	Evaluate matrix effects (interference or bias).
Meteorological Data and Site Conditions	Evaluate the possible effects of meteorological (e.g., wind, rain, temperature) and site conditions on sample results. Review field reports to identify whether any unusual conditions were present and how the sampling plan was executed.
Comparability	Ensure that results from different data collection activities achieve an acceptable level of agreement.
Completeness	Evaluate the impact of missing information. Ensure that enough information was obtained for the data to be usable (completeness as defined in PQOs documented in the QAPP).
Background	Determine if background levels have been adequately established (if appropriate).
Critical Samples	Establish that critical samples and critical target analytes/COCs, as defined in the QAPP, were collected and analyzed. Determine if the results meet criteria specified in the QAPP.
Data Restrictions	Describe the exact process for handling data that do not meet PQOs (i.e., when measurement performance criteria are not met). Depending on how those data will be used, specify the restrictions on use of those data for environmental decision-making.
Usability Decision	Determine if the data can be used to make a specific decision considering the implications of all deviations and corrective actions
Usability Report	Discuss and compare overall precision, accuracy/bias, representativeness, comparability, completeness, and sensitivity for each matrix, analytical group, and concentration level. Describe limitations on the use of project data if criteria for data quality indicators are not met.

Table 13 Considerations for Usability Assessment

Appendix A: UST Management Division RBCA Decision Making Flow Chart


UST Decision Making Flowchart
Release Reported
Impacted Receptor
Are soil & groundwater CoC > RBSL?
No
Regulatory NFA
Yes
Are monitoring wells present?
Yes, soil only CoC or water CoC < 10x RBSL
Yes, water CoC 10x RBSL
Conduct IGWA
Resample
Are water CoC > RBSL?
Yes
No
NFA Issued
Are water CoC > RBSL?
Yes
Are CoC 10x RBSL or product present?
No
Conduct Tier I
No
Yes
Is Product >0.01 foot?
No
Yes
Are Soil CoC > RBSL?
No
Yes
NFA Issued
Conduct additional assessment
Are CoC > RBSL?
Yes
No
Are CoC 10x RBSL or product present?
Yes
No
Resample
Are CoC > RBSL?
Yes
No
Is soil & water defined?
Conduct Tier II & AFVR if appropriate
Yes
Reassign to Corrective Action


Are
CoC > SSTLs?
Yes
Active Corrective
Action
No
No
Is
Free product
present?
Yes
Conduct AFVR
Events
Are AFVRs
effective?
Yes
No
Monitored Natural
Attenuation
Are CoC <
SSTLs and is
plume stable?
No
Yes
Groundwater
sampling
event
conducted
No
Is
Plume stable?
Yes
NFA issued

Appendix B: Contractor Addendum

Note to Contractors and those using this Addendum form:

1. Once the form is completed, DELETE THIS SECTION
2. Instructions for filling in this Addendum are in red as are suggestions for what needs to go in the document. Tables and other figures that can be used as part of the Addendum---just adjusted for the project will be in black. Anything in red should be deleted out of the QAPP Addendum.
3. In each Section there is generic information or instructions, however, please refer to the SC DHEC QAPP Guide available at http://www.scdhec.gov/environment/envserv/qaguidance.htm
4. This is considered an ADDENDUM to the UST Programmatic QAPP. While the Programmatic QAPP gives specific direction, this addendum will fill in site specific/lab specific/contractor specific information. Please refer to each section of the UST QAPP as this Addendum is prepared. Realize that this Addendum is supposed to be site specific.
5. For help with the parts of the QAPP call the SC DHEC Office of Quality Assurance (OQA) at 803-896-0862 or 0981. For help with specific UST issues please contact your UST Project Manager.
6. Please understand that you are responsible for anything in the programmatic QAPP as well as what is in the Addendum you produce for the project.

Section A: Project Management

A1 Title and Approval Page

Quality Assurance Project Plan
Addendum to the SC DHEC UST Programmatic QAPP
For

Name of Project/Site and UST Permit Number

Site Location (Address, City, State)

Prepared by:________________________________

Affiliation and Contact Information

Date:______________________________________

Day/Month/Year

Name of Certified Contractor

Approvals

Name
SC DHEC Project Manager ______________________ Signature Date__________

Name
Contractor QA Manager ______________________ Signature Date__________

Name
Site Rehabilitation Contractor ______________________ Signature Date__________

Name
Laboratory Director ______________________ Signature Date__________

A2 Table of Contents

A3 Distribution List

The distribution list is a list of individuals either directly participating in the Project or overseeing the project. Those listed in the distribution list in the Master QAPP are to receive a copy of the QAPP. Those listed below will receive a copy of the Master QAPP and the Site-Specific QAPP Addendum as well as any updates/revisions. Please notice that some DHEC titles are already listed below and along with their addresses. The writer of the QAPP Addendum is to identify the SCDHEC Technical Project that is assigned to this specific project in the table below. Additional rows are left for other personnel who are essential to this project either from SC DHEC, or subcontractors.

Name	Title	Organization/Address	Telephone Number	Fax Number	Email Address
	SC DHEC Technical Project Manager	SCDHEC, UST Management Division, 2600 Bull St., Columbia, SC, 29201	803-896-6241	803-896-6245	
	Site Rehabilitation Contractor				
	Field Manager				
	Well Services/Driller				
	Laboratory Director				

Table 1A Addendum Distribution List

A4 Project Organization

The Master UST QAPP has specific roles and the responsibilities of each role outlined in Section A4, however, personnel assigned to these roles must be identified in this QAPP Addendum. Anyone performing essential functions in this project (not given in the Master UST QAPP) should be given below and their duties outlined. The Table below may be used to do this or the Roles may simply be listed as they are in the Master UST QAPP and this Table can be deleted. If there are no other roles to be given, delete the Table below.

Role from the UST Master QAPP	Name of person in this Role for this Project	Organization/Address	Telephone Number	Fax Number	Email Address
Project Manager		SCDHEC, UST Management Division, 2600 Bull St., Columbia, SC, 29201	803-896-6241	803-896-6245	
Site Rehabilitation Contractor					
Field Manager					
Analytical Laboratory Director					
Soil Boring and Monitoring Well Driller					
Project Verifier					

Table 2A Addendum Role Identification and Contact Information

An organization chart is necessary for every project. The organization chart below is an example, but it can be used to construct the organizational chart for this project.

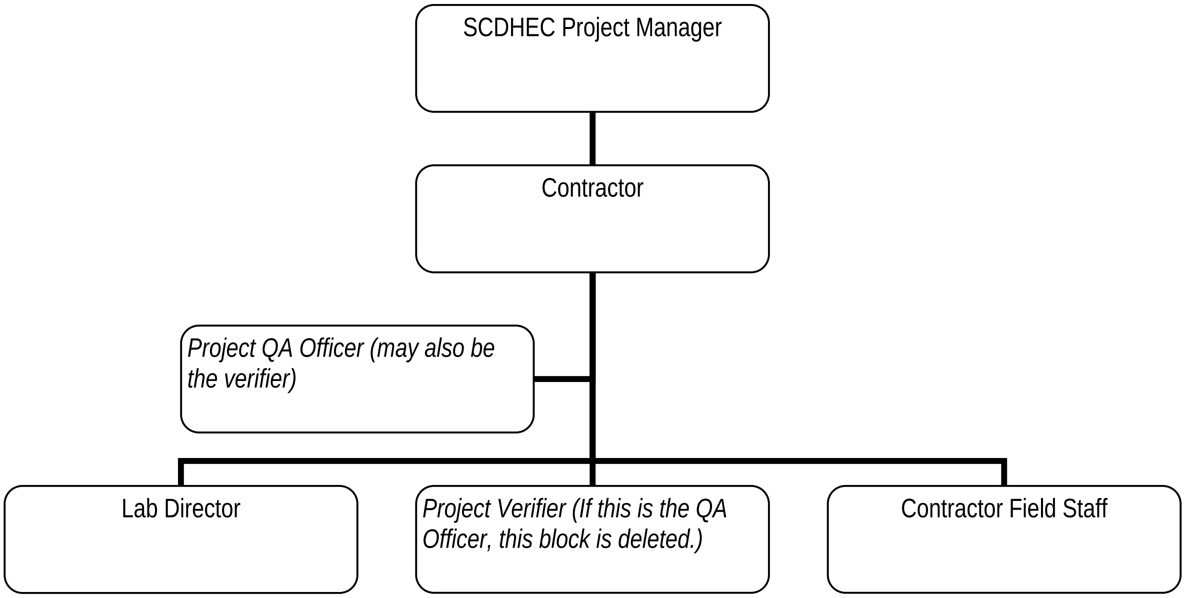


Figure 1A Organizational Chart (Example)

A5 Problem Definition/Background

Discuss the background (as much as is known) of the site and appropriate historical information, and why this site is being assessed.

Please answer the following: Does this project fall under UST or Brownfields area?

A6 Project/Task Description

1. *Summarize what is known about the work to be done. This can be a short sentence indicating what the Scope of this project is (see Master QAPP Section A6).*

2. *The work will begin within __________________ after cost approval and sampling should be complete   by__________________________.*

3. *Are there are time or resource constraints? Include those factors that may interfere with the tentative schedule.*

A7 Data Quality Objectives (DQOs) and Data Quality Indicators (DQIs)

The Addendum will complete what is given in the Programmatic QAPP Guide on the DQO Process. Specifically this is Step 4: Defining the Study boundary—which includes a map of the property (Attachment) to show what the extent of the study will cover.

Detail the geographical area that is to be part of the project. Maps should be included to show not only the topography and the geographical area of the State, but also to show more detail of the site itself including property lines.

A8 Training and Certificates

It is necessary to state which individuals must have training/licensing in order to do a job on this project, who they are and when they received the training or the license. Examples would be well drillers that must be licensed in SC. This information goes in the table. Below the table you must indicate who is responsible for ensuring that personnel involved in the project have the proper training and where the records of the training are kept. The Labs that will be used for this project must be certified by the SCDHEC Office of Environmental Certification for every analysis that they will perform. The information for the Laboratories and their SC DHEC Certificate number must be included in this addendum.

Required training and licenses:

Title/Job	Name	Training Required	Date training received	Type of License	License Number

Table 3A Required Training and Licenses

________(Name)____________ of ______(Company)________________ is responsible to ensuring that personnel participating in this project receive the proper training. All training records will be stored in the following location:____

<u>It is understood that training records will be produced if requested by SC DHEC.</u>

The Following Laboratory(ies) will be used for this Project:
All labs being used (including ones subcontracted) must be included.

Commercial Lab(s)

Please give the information as listed below for each Laboratory that is being used for sample analysis.

Full Name of the Laboratory____
Name of Lab Director____
SC DHEC Certification Number____
Parameters this Lab will analyze for this project:

Full Name of the Laboratory____
Name of Lab Director____
SC DHEC Certification Number____
Parameters this Lab will analyze for this project:

(If more than 2 labs are being used, copy the above 4 lines and insert into this document)

Please note: SC DHEC may require that the contractor submit some or all of the Laboratory's SOPs as part of this QAPP.

A9 Documents and Records

Personnel will receive the most current version of the QAPP Addendum via:
(Check all that apply)

____US Mail ____Courier ____Hand delivered

Other (please specify):____

This section requires a list of the records—pertinent to the project- produced during the project by the Contractor, Laboratories, and Subcontractors. Please note that the Programmatic QAPP requires records to be kept at least 5 years.

Record	Produced By	Hardcopy/ Electronic	Storage Location For how long?	Archival

Record	Produced By	Hardcopy/ Electronic	Storage Location For how long?	Archival

Table 4A Record Identification, Storage, and Disposal

Section B Measurement/Data Acquisition

B1 Sampling Process/Experimental Design

In the table below list the schedule for project activities. This would include drilling the wells, developing the wells, collecting samples and so on.

Item	Start Date	End Date	Comments

Table 5A Sampling Activities

B2 Sampling Methods

Please note: The contractor must follow sampling protocols as given in the UST QAPP.

Estimate the number of samples of each matrix that are expected to be collected:

Soil ___________

Ground Water from monitoring wells ___________

From Drinking/Irrigation water wells ___________

From surface water features ___________

Total number of Water samples ___________

In this next part indicate if the samples will be homogenized and split and describe the way this will be done.

The samples will be (check as many as apply): ____Homogenized ____Split

For the sample matrices indicated above, please describe how samples will be collected and the equipment needed.

Will Sampling Equipment have to be cleaned and decontaminated or is everything disposable?

If sampling equipment must be cleaned please give a detailed description of how this is done and the disposal of by-products from the cleaning and decontamination.

Identify any equipment and support facilities needed. This may include such things as Fed-ex to ship the samples, a Geoprobe, field analysis done by another contractor (who must be certified), and electricity to run sampling equipment.

Address the actions to be taken when problems occur in the field, and the person responsible for taking corrective action and how the corrective action will be documented.

Failure	Response	Documentation	Individual Responsible

Table 6A Field Corrective Action

B3 Sample Handling and Custody

This section deals with how samples are physically handled. Please answer the following questions and please attach a copy of the Lab's chain of custody. If multiple labs are used along with multiple chains of custody, all of them must be attached. The chain of custody procedure should describe how the sample's location is accounted from collection to disposal (for each lab). If the laboratory has a SOP for this, it may be attached as long as sampling personnel understand that they must adhere to it. Please note that holding times and preservation for samples must adhere to the requirements in the Master UST QAPP. Preservation and sample handling details must be given in either a case narrative or on the Chain of Custody.

1. *How will the samples get from the Site to the Lab to ensure holding requirements are met?*

2. *How will the contactors cool the samples and keep the samples cool?*

3. *How will the lab determine the temperature of the samples upon receipt? Will they be using a temperature blank?*

4. *Where will the samples be stored in the Lab once they are received?*

5. *Describe the chain of custody procedure and attach a copy of each chain of custody that will be used. If a Chain of Custody SOP exists from the Lab and the Contractor is willing to adhere to it, then this may be attached.*

B4 Analytical Methods

This section will give specific information about exactly which Methods will be used for analysis. The allowable methods are given in the Programmatic QAPP, but often there are choices so the Contractor's addendum must list the exact methods that will be used. Although the SOPs of the lab are reviewed during their Laboratory Certification Process, UST or the OQA may require submission of some or all SOPs. SOPs may be identified by the full nomenclature from the lab or by abbreviation as long as the abbreviations are explained.

The tables below may be used for the first requirement.

1. *Identify the SOPs which will be used to analyze the samples, the method which the SOP references and the equipment or instrumentation that is needed:*

Parameter	SOP ID*	Method Referenced	Equipment	Comments

Table 7A Analytical SOPs and Referenced Methods

- This can be a full name of a SOP, an abbreviation, or a number. In the latter two cases, the abbreviation or number must be associated with the full name of the SOP. See also Table 8A SOP Abbreviation Key.

Abbreviation	Lab Identification of this SOP	Full Name of the SOP

Table 8A SOP Abbreviation Key

Item 2 may be in an attachment from the Lab from their QA/QC plan or it may be a table (see Table 8A) or a combination because the Lab has a QA/QC plan that states what is done, but field personnel do not.

2. Identify procedures to follow when failures occur, identify the individual responsible for corrective action and appropriate documentation:

Failure	Response	Documented Where?	Individual Responsible

Table 9A Corrective Action Procedures

3. Identify sample disposal procedures.

Analysis	Matrix	Schedule for disposal	Method for disposal	Comments

Table 10A Sample Disposal

4. Provide SOPs for the Kerr Method or the Ferrous Iron Method if these are parameters for this study. This can be attached or written here. If attached please note that it is an attachment and where it is located (if applicable).

B5 Quality Control Requirements:

All QC will follow the requirements laid out in Section B5 of the UST Programmatic QAPP.

B6 Field Instrument and Equipment Testing, Inspection and Maintenance

1. Identify all field and laboratory equipment needing periodic maintenance, the schedule for this, and the person responsible. Note the availability and location of spare parts.

Instrument	Serial Number	Type of Maintenance	Frequency	Parts	Person responsible

				needed/Location	

Table 11A Instrument and Equipment Maintenance

2. Identify the testing criteria for each lab or field instrument that is used to ensure the equipment is performing properly. Indicate how deficiencies, if found, will be resolved, re-inspections performed, and effectiveness of corrective action determined and documented. Give the person responsible for this

Instrument/Equipment & Serial Number	Type of Inspection	Requirement	Individual Responsible	Resolution of Deficiencies

Table 12A Instrument and Equipment Inspection

B7 Instrument Calibration and Frequency

1. Identify equipment, tools, and instruments for field or lab work that should be calibrated and the frequency.
2. Describe how the calibrations should be performed and documented, indicating test criteria and standards or certified equipment.
3. Identify how deficiencies should be resolved and documented. Identify the person responsible for corrective action.

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference*

Table 13A Instrument Calibration Criteria and Corrective Action

* This can be a full name of a SOP, an abbreviation, or a number. In the latter two cases, the abbreviation or number must be associated with the full name of the SOP. See also Table 8A SOP Abbreviation Key.

B8 Inspection/Acceptance Requirements for Supplies and Consumables

1. Identify critical supplies and consumables for field and laboratory, noting supply source, acceptance criteria, and procedures for tracking, storing and retrieving these materials.
2. Identify the individual(s) responsible for this.

Consumables are things like disposable bailers, nitrile gloves, sample containers, and so on.

Item	Vendor	Acceptance criteria	Handling/Storage Conditions	Person responsible for inspection and tracking.

Table 14A List of Consumables and Acceptance Criteria

B9 Data Acquisition Requirements (Non-Direct Measurements)

This section discusses data that was not generated by this project. This includes historical data, information Tax Maps, computer data bases, weather data from the National Weather Service, Scientific Literature, and so on. This discussion must include information about why this data is usable for this project.

1. Identify data sources, for example, computer databases or literature files, or models that should be accessed or used.
2. Describe the intended use of this information and the rationale for their selection, i.e., its relevance to project.
3. Indicate the acceptance criteria for these data sources and/or models.

Data Source	Used for	Justification for use in this project	Comments

Table 15A Non-Direct Measurements

4. Identify key resources/support facilities needed. This will probably be Non-applicable for most projects. This would be addressed if the contractor employed someone to provide data modeling, database upkeep, and so on.

B10 Data Management

1. Describe the data management scheme from field to final use and storage.

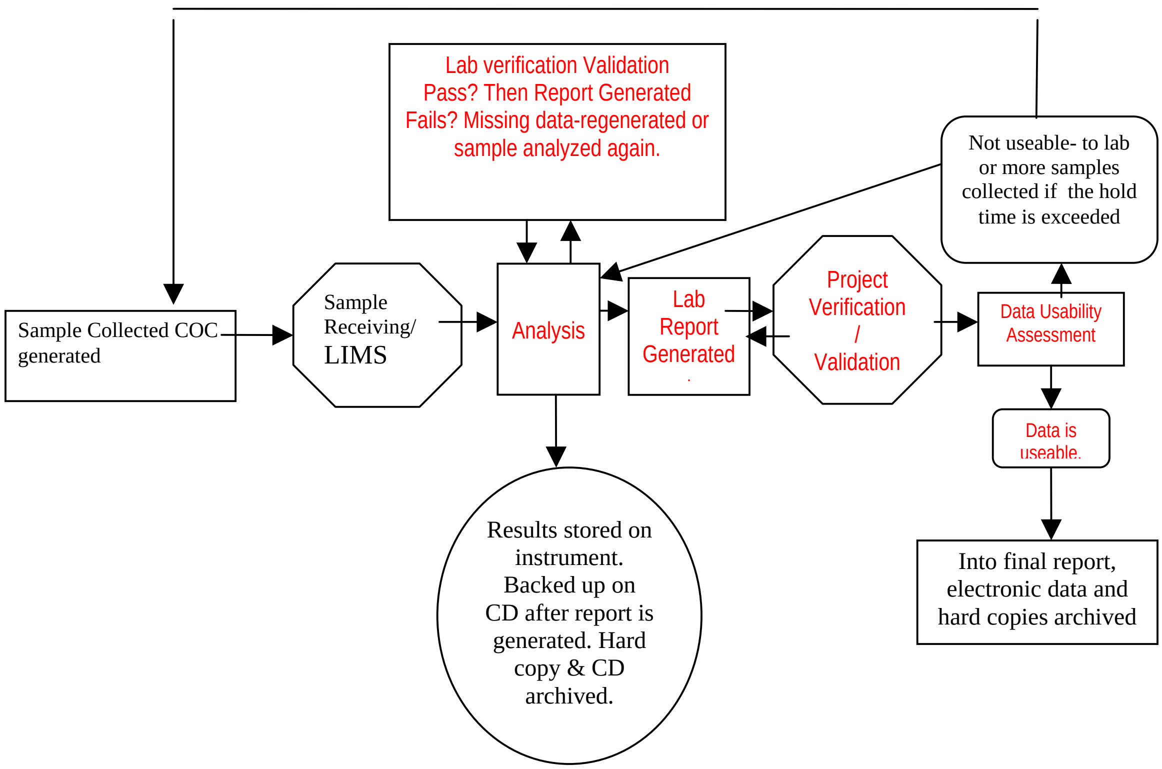


Figure 2 Example of a Data Management Scheme

A diagram, such as the one above, can be used to satisfy Item 1 or a description can be used instead.

2. How does the lab and field staff ensure that no unauthorized changes are made to the chain of custody, sampling notebooks, laboratory notebooks and computer records?
3. How does the lab ensure that there are no errors in samples records including times when sample information is compiled, data calculated and/or transmitted.

Items 2 and 3: This is a discussion of how errors will be avoided. This includes errors in the field paperwork, chain of custody and laboratory processes. Usually this is done by overview of a supervisor who looks over work or rechecks calculations. Software issues also come into play here. Is there a process to keep data from being corrupted or restoring it if the data becomes corrupted? Is there a process to avoid data loss though computer malfunctions? What about security of the data? Is the data protected from tampering? How does the Lab or contractor know that the software/hardware that is used is acceptable? In each process identify who is responsible for oversight.

4. How will the data be archived once the report is produced? How can it be retrieved? (This applies to both electronic and hard copies).

Section C Assessment and Oversight

C1 Assessment and Response Actions

1. *The Contractor is supposed to observe field personnel daily during sampling activities to ensure samples are collected and handled properly and report problems to DHEC within 24 hours. . Please state who is responsible for doing this and what observations will be made. Will this person have the authority to stop work if severe problems are seen?*
2. *The SCDHEC UST QAPP states that the Lab will receive an Offsite Technical System Audit. For this project, what assessments will be done on the Commercial Lab(s) that are being used—other than their certification audit? When or how often are these done? Who will the results be given to and who has the ability to stop work if problems are severe?*

C2 Reports to Management

See the SC DHEC UST Programmatic QAPP (UST Master QAPP).

Section D Data Validation and Usability

See the SC DHEC UST Programmatic QAPP (UST Master QAPP).

Appendix C: RBSL Look-Up Tables

Table C1
RBSL'S for Ground Water

Chemical of Concern	Concentration
Benzene	5 µg/L
Toluene	1,000 µg/L
Ethylbenzene	700 µg/L
Xylenes	10,000 µg/L
Total PAHs#	25 µg/L
MTBE	40 µg/L
Naphthalene	25 µg/L
1,2-DCA	5 µg/L
EDB λ	0.05 µg/L
Lead λ	15 µg/L
Arsenic **	50 µg/L
Barium **	2,000 µg/L
Cadmium **	5 µg/L
Chromium **	100 µg/L
Mercury **	2 µg/L
Selenium **	50 µg/L
Silver **	5 µg/L

In calculating SSTLs for individual PAHs (Benzo(a)anthracene, Benzo(b)flouranthene, Benzo(k)flouranthene, Chrysene, and Dibenz(a,h)anthracene), please use an RBSL of 10 µg/L for each CoC.

λ UST system was in operation prior to 1991.

** For waste oil UST releases only.

Table C2
RBSLs for Sandy Soil determined based on groundwater RBSLs.

Chemical of Concern	RBSL (mg/Kg) (for all separation distances)
Benzene	0.007
Toluene	1.450
Ethylbenzene	1.150
Xylenes	14.500
Naphthalenes	0.036
Benzo(a)anthracene	0.66
Benzo(b)flouranthene	0.66
Benzo(k)flouranthene	0.66
Chrysene	0.66
Dibenz(a,h)anthracene	0.66

Table C3
RBSLs for Clay-rich Soil (mg/kg)

Separation Distance → ↓ Chemical of Concern	<10 ft	10-15 ft	15-20 ft	20-25 ft	25-30 ft	>30 ft
Benzene	0.003	0.008	0.037	0.187	1.010	5.665
Toluene	0.627	1.167	3.630	12.085	41.885	149.125
Ethylbenzene	1.551	6.168	76.950	1114.5	-	-
Xylenes	13.010	22.495	61.250	176.800	529.000	-
Naphthalenes	0.047	0.069	0.139	0.292	0.625	1.350
Benzo(a)anthracene	0.066*	-	-	-	-	-
Benzo(b)flouranthene	0.066*	7439.0	-	-	-	-
Benzo(k)flouranthene	0.066*	-	-	-	-	-
Chrysene	0.066*	13.099	59.800	298.550	1573.000	-
Dibenz(a,h)anthracene	0.066*	-	-	-	-	-

Note: Separation Distance is measured from the depth of the worst case soil sample to the top of the water table.

* Limits are increased to levels above the calculated values to reasonably attainable laboratory reporting limits.

\- Indicates that the values are above saturation levels

Table C4
RBSLs for Inhalation of vapors

Chemical of Concern	RBSL (μg/m^3)
Benzene	0.22
Toluene	420
Ethylbenzene	1,100
Xylene	7,300
Methyl Tert-Butyl Ether	3,100

Note: RBSLs for the PAHs are not of concern because of their low volatility.

<u>Table C5</u>

RBSLs for Ingestion or Dermal Contact with Surficial Soil

Chemical of Concern	Residential (mg/kg)	Industrial (mg/kg)
Benzene	12	100
Toluene	16,000	410,000
Ethylbenzene	7,800	200,000
Xylene	160,000	4,100,000
Methyl Tert-Butyl Ether	390	10,000
Naphthalenes	3,100	41,000
Benzo(a)anthracene	0.88	3.9
Benzo(b)fluoranthene	0.88	3.9
Benzo(k)fluoranthene	8.8	39
Chrysene	88	390
Dibenzo(a,h)anthracene	0.088	0.39

Appendix D: Site Conceptual Models

Site Conceptual Model - CURRENT LAND USE

Media (for exposure)	Exposure Route	Pathway Selected for Evaluation? (Yes or No)	Exposure point or Reason for Non-Selection	Data Requirements (IF pathway selected)
Air	Inhalation	Yes No		
	Explosion Hazard	Yes No		
Ground-Water	Ingestion	Yes No		
	Dermal Contact	Yes No		
	Inhalation	Yes No		
Surface Water	Ingestion	Yes No		
	Dermal contact	Yes No		
	Inhalation	Yes No		
Surficial Soil	Ingestion	Yes No		
	Dermal contact	Yes No		
	Inhalation	Yes No		
	Leaching to Ground-Water	Yes No		
Subsurface Soil	Ingestion	Yes No		
	Dermal contact	Yes No		
	Inhalation	Yes No		
	Leaching to Ground-Water	Yes No		

Site Conceptual Model - FUTURE LAND USE

Media (for exposure)	Exposure Route	Pathway Selected for Evaluation? (Yes or No)	Exposure point or Reason for Non-Selection	Data Requirements (IF pathway selected)
Air	Inhalation	Yes No		
	Explosion Hazard	Yes No		
Ground-Water	Ingestion	Yes No		
	Dermal Contact	Yes No		
	Inhalation	Yes No		
Surface Water	Ingestion	Yes No		
	Dermal contact	Yes No		
	Inhalation	Yes No		
Surficial Soil	Ingestion	Yes No		
	Dermal contact	Yes No		
	Inhalation	Yes No		
	Leaching to Ground-Water	Yes No		
Subsurface Soil	Ingestion	Yes No		
	Dermal contact	Yes No		
	Inhalation	Yes No		
	Leaching to Ground-Water	Yes No		

Appendix E: Analytical Parameters and Methods

Table E1
Analytical Precision and Accuracy for Water Samples

Analyte	Analytical Method	Reporting Limit*		Laboratory Control Sample (LCS) % Recovery	Matrix Spike Samples % Recovery	Precision Relative Percent Difference %RPD
		Groundwater	Drinking Water and Receptors			
Benzene	5030B with 8260B	5 µg/L	0.5 µg/L	70 – 130%	70 – 130%	20
Toluene	5030B with 8260B	5 µg/L	0.5 µg/L	70 – 130%	70 – 130%	20
Ethylbenzene	5030B with 8260B	5 µg/L	0.5 µg/L	70 – 130%	70 – 130%	20
Total Xylenes	5030B with 8260B	10 µg/L	0.5 µg/L	70 – 130%	70 – 130%	20
Naphthalene	5030B with 8260B	5 µg/L	2 µg/L	70 – 130%	70 – 130%	20
1,2-Dichloroethane	5030B with 8260B	5 µg/L	0.5 µg/L	70 – 130%	70 – 130%	20
MTBE	5030B with 8260B	5 µg/L	5 µg/L	70 – 130%	70 – 130%	20
EDB	8011	0. 05 µg/L	0~~.005~~02 µg/L	60 – 140%	~~50~~ 60 – ~~150~~140%	20
ETBE	5030B with 8260B-oxy	100 µg/L	100 µg/L	70 – 130%	70 – 130%	20
3,3-dimethyl-1-butanol	5030B with 8260B-oxy	100 µg/L	100 µg/L	70 – 130%	70 – 130%	20
TAME	5030B with 8260B-oxy	10 µg/L	10 µg/L	70 – 130%	70 – 130%	20
DIPE	5030B with 8260B-oxy	10 µg/L	10 µg/L	70 – 130%	70 – 130%	20
TBF	5030B with 8260B-oxy	100 µg/L	100 µg/L	70 – 130%	70 – 130%	20
TBA	5030B with 8260B-oxy	100 µg/L	100 µg/L	70 – 130%	70 – 130%	20
TAA	5030B with 8260B-oxy	100 µg/L	100 µg/L	70 – 130%	70 – 130%	20
Ethanol	5030B with 8260B-oxy	1,000 µg/L	1,000 µg/L	70 – 130%	70 – 130%	20

Analyte	Analytical Method	Reporting Limit*		Laboratory Control Sample (LCS) % Recovery	Matrix Spike Samples % Recovery	Precision Relative Percent Difference %RPD
		Groundwater	Drinking Water and Receptors			
1,2,4- and 1,3,5-trimethyl benzene isomers	5030B with 8260B	5 µg/L	5 µg/L	70 – 130%	70 – 130%	20
n-butyl, sec-butyl, and tert-butyl benzene isomers	5030B with 8260B	5 µg/L	5 µg/L	70 – 130%	70 – 130%	20
Isopropyl benzene	5030B with 8260B	5 µg/L	5 µg/L	70 – 130%	70 – 130%	20
n-propyl benzene	5030B with 8260B	5 µg/L	5 µg/L	70 – 130%	70 – 130%	20
Full List 8260B Scan	5030B with 8260B	Analyte specific	Analyte specific	70 – 130%	70 – 130%	20
Benzo(a)anthracene	3510C with 8270D	10 µg/L	NA	70 – 130%	40 – 150%	20
Benzo(b)flouranthene	3510C with 8270D	10 µg/L	NA	70 – 130%	40 – 150%	20
Benzo(k)flouranthene	3510C with 8270D	10 µg/L	NA	70 – 130%	40 – 150%	20
Chrysene	3510C with 8270D	10 µg/L	NA	70 – 130%	40 – 150%	20
Dibenz(a,h)anthracene	3510C with 8270D	10 µg/L	NA	70 – 130%	40 – 150%	20
TPH (Oil & Grease)	9070A	40 mg/L	NA	78 – 114%	78 - 114	20
Arsenic	6020A or 7010	5 µg/L	5 µg/L	80 - 120%	75 – 125%	20
Barium	6010C or 6020A	50 µg/L	50 µg/L	80 - 120%	75 – 125%	20
Cadmium	6010C, 6020A, or 7010	1 µg/L	1 µg/L	80 - 120%	75 – 125%	20
Chromium	6010C, 6020A, or 7010	5 µg/L	5 µg/L	80 - 120%	75 – 125%	20
Lead	6010C, 6020A, or 7010	5 µg/L	5 µg/L	80 - 120%	75 – 125%	20
Mercury	7470A	0.2 µg/L	0.2 µg/L	80 - 120%	75 – 125%	20
Selenium	6020A or 7010	5 µg/L	5 µg/L	80 - 120%	75 – 125%	20

Analyte	Analytical Method	Reporting Limit*		Laboratory Control Sample (LCS) % Recovery	Matrix Spike Samples % Recovery	Precision Relative Percent Difference %RPD
		Groundwater	Drinking Water and Receptors			
Silver	6010C, 6020A, or 7010	5 µg/L	5 µg/L	80 - 120%	75 – 125%	20
Nitrate	9210A or 9056A	100 µg/L	NA	NA	80-120%	20
Sulfate	9056A	1000 µg/L	NA	80 - 120%	80 - 120%	20
Methane	Kerr Method RSKSOP-175 rev 2, May 2004	10,000 µg/L	10,000 µg/L	85-115%	NA	NA
Ferrous Iron	SM3500-Fe D	10 µg/L	10 µg/L	90-110%	85-115%	≤ 20%
pH	9040C	NA	NA	NA	NA	NA
Conductivity	9050A	10	10	NA	NA	NA
Turbidity	SM-2130B	1	1	NA	NA	NA
Temperature	SM-2550B	NA	NA	NA	NA	NA
Dissolved Oxygen	SM-4500 O G	1,000 µg/L	1,000 µg/L	NA	NA	NA

*A reporting limit standard must be included as part of the calibration curve. Use of non-linear calibration models is not acceptable.

Table E2

Analytical Precision and Accuracy for Soil Samples

Analyte	Analytical Method	Reporting Limit*	Laboratory Control Sample (LCS) % Recovery	Matrix Spike Sample % Recovery	Precision Relative Percent Difference %RPD
Benzene[w]	5035 with 8260B	5 ug/Kg	70 – 130%	70 – 130%	20
Toluene[w]	5035 with 8260B	5 ug/Kg	70 – 130%	70 – 130%	20
Ethylbenzene[w]	5035 with 8260B	5 ug/Kg	70 – 130%	70 – 130%	20
Xylenes[w]	5035 with 8260B	10 ug/Kg	70 – 130%	70 – 130%	20
Naphthalene[w]	5030 with 8260B	5 ug/Kg	70 – 130%	50 – 150%	20
MTBE[w]	5030 with 8260B	5 ug/Kg	70 – 130%	50 – 150%	20
Benzo(a)anthracene	3550C with 8270D	660 ug/Kg	70 – 130%	50 – 150%	20
Benzo(b)flouranthene	3550C with 8270D	660 ug/Kg	70 – 130%	50 – 150%	20
Benzo(k)flouranthene	3550C with 8270D	660 ug/Kg	70 – 130%	50 – 150%	20
Chrysene	3550C with 8270D	660 ug/Kg	70 – 130%	50 – 150%	20
Dibenz(a,h)anthracene	3550C with 8270D	660 ug/Kg	70 – 130%	50-150%	20
TPH (DRO)	3550C with 8015C	10 mg/Kg	70 – 130%	60 – 140%	20
TPH (GRO) [w]	5035B with 8015C	10 mg/Kg	70 – 130%	60 – 140%	20
Oil & Grease [w]	9071B	10 mg/Kg	70 – 130%	60 – 140%	20
Arsenic	6020A or 7010	250 ug/Kg	80 - 120%	75 – 125%	20
Barium	6010C or 6020A	250 ug/Kg	80 - 120%	75 – 125%	20
Cadmium	6010C, 6020A, or 7010	250 ug/Kg	80 - 120%	75 – 125%	20
Chromium	6010C or 6020A	250 ug/Kg	80 - 120%	75 – 125%	20
Lead	6010C, 6020A, or 7010	250 ug/Kg	80 - 120%	75 – 125%	20
Mercury	7471B	10 ug/Kg	80 - 120%	75 – 125%	20
Selenium	6020A or 7010	250 ug/Kg	80 - 120%	75 – 125%	20
Silver	6010C, 6020A, or 7010	250 ug/Kg	80 - 120%	75 – 125%	20

Analyte	Analytical Method	Reporting Limit*	Laboratory Control Sample (LCS) % Recovery	Matrix Spike Sample % Recovery	Precision Relative Percent Difference %RPD
TCLP	1311	Applicable Method Limits			
Total Organic Carbon (TOC)**	9060A	0.1 mg/Kg	90 - 110%	70 – 130%	20

* A reporting limit standard must be included as part of the calibration curve. Use of non-linear calibration models is not acceptable.

** TOC must be performed using a TOC analyzer equipped with a soil sample attachment.

w Analytical results to be reported as wet weight.

Appendix F: Preservation and Holding Times

Table F1
Sample Preservation and Holding Times for Groundwater

Analyte	Analytical Method	Container	Preservation	Holding Time
Benzene	5030 with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
Toluene	5030 with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
Ethylbenzene	5030 with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
Total Xylenes	5030 with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
Total Naphthalenes	5030 with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
1,2-Dichloroethane	5030 with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
MTBE	5030 with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
EDB	8011	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with HCl, Residual Chlorine present: add $Na_2S_2O_3$ to make 0.008% concentration	14 days
ETBE	5030B with 8260B-oxy	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
3,3-Dimethyl-1-butanol	5030B with 8260B-oxy	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
TAME	5030B with 8260B-oxy	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
DIPE	5030B with 8260B-oxy	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
TBF	5030B with 8260B-oxy	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
TBA	5030B with 8260B-oxy	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
TAA	5030B with 8260B-oxy	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days

Analyte	Analytical Method	Container	Preservation	Holding Time
Ethanol	5030B with 8260B-oxy	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
1,2,4- and 1,3,5-trimethyl benzene isomers	5030B with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
n-butyl, sec-butyl, and tert-butyl benzene isomers	5030B with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
Isopropyl benzene	5030B with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
n-propyl benzene	5030B with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C and adjust pH to less than 2 with H_2SO_4 or HCl	14 days
Full List 8260B Scan	5030B with 8260B	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C	7 days
Benzo(a)anthracene	3510C with 8270C	Amber glass container with Teflon-lined lid	Cool to 4° C	7 days until extraction 40 days after extraction
Benzo(b)flouranthene	3510C with 8270C	Amber glass container with Teflon-lined lid	Cool to 6° C	7 days until extraction 40 days after extraction
Benzo(k)flouranthene	3510C with 8270C	Amber glass container with Teflon-lined lid	Cool to 6° C	7 days until extraction 40 days after extraction
Chrysene	3510C with 8270C	Amber glass container with Teflon-lined lid	Cool to 6° C	7 days until extraction 40 days after extraction
Dibenz(a,h)anthracene	3510C with 8270C	Amber glass container with Teflon-lined lid	Cool to 6° C	7 days until extraction 40 days after extraction
TPH (Oil & Grease)	9070A	1 Liter Glass	Cool to 6° C pH to less than 2 with H_2SO_4 or HCl	28 days
Arsenic	6020A or 7010	Polyethylene or Glass	HNO_3 to pH <2	6 months

Analyte	Analytical Method	Container	Preservation	Holding Time
Barium	6010C or 6020A	Polyethylene or Glass	HNO_3 to pH <2	6 months
Cadmium	6010C, 6020A, or 7010	Polyethylene or Glass	HNO_3 to pH <2	6 months
Chromium	6010C, 6020A, or 7010	Polyethylene or Glass	HNO_3 to pH <2	6 months
Lead	6010C, 6020A, or 7010	Polyethylene or Glass	HNO_3 to pH <2	6 months
Mercury	7470A	Polyethylene or Glass	HNO_3 to pH <2	28 days
Selenium	6020A or 7010	Polyethylene or Glass	HNO_3 to pH <2	6 months
Silver	6010C, 6020A, or 7010	Polyethylene or Glass	HNO_3 to pH <2	6 months
Nitrate	9210 or 9056	Polyethylene or Glass	Cool to 4° C	48 hours
Sulfate	9056	Polyethylene or Glass	Cool to 4° C	28 days
Methane	Kerr Method RSKSOP-175 rev 2, May 2004	2 x 40 ml glass vials with Teflon-lined septum caps	Cool to 6° C, pH < 2 with 1:1 HCl	14 days
Ferrous Iron	SM3500-Fe D	Glass	None	48 hours [1]
pH	9040C	NA	NA	Within 15 minutes
Conductivity	9050A	NA	Cool to 4° C	28 days
Turbidity	SM-2130B	NA	Cool to ≤ 6° C	48 hours
Temperature	SM-2550B	NA	NA	Within 15 minutes
Dissolved Oxygen	SM-4500 O G or ASTM D888-05	NA	NA	Within 15 minutes

[1] Analysis should be performed immediately in the field; however, if analysis is done in a laboratory, holding time is not to exceed 48 hours

Table F2

Sample Preservation & Holding Times for Soil

Analyte	Analytical Method	Container	Preservation	Holding Time
Benzene	5035 with 8260B	See Method for Requirements in SW 846		
Toluene	5035 with 8260B			
Ethylbenzene	5035 with 8260B			
Xylenes	5035 with 8260B			
Total Naphthalenes	5035 with 8260B			
MTBE	5035 with 8260B			
Benzo(a)anthracene	3535A, 3540C, 3541, 3545A or 3550C with 8270D	Amber glass with Teflon-lined lid	Cool to 6° C	14 days until extraction 40 days after extraction
Benzo(b)flouranthene	3535A, 3540C, 3541, 3545A or 3550C with 8270D	Amber glass with Teflon-lined lid	Cool to 6° C	14 days until extraction 40 days after extraction
Benzo(k)flouranthene	3535A, 3540C, 3541, 3545A or 3550C with 8270D	Amber glass with Teflon-lined lid	Cool to 6° C	14 days until extraction 40 days after extraction
Chrysene	3535A, 3540C, 3541, 3545A or 3550C with 8270D	Amber glass with Teflon-lined lid	Cool to 6° C	14 days until extraction 40 days after extraction
Dibenz(a,h)anthracene	3535A, 3540C, 3541, 3545A or 3550C with 8270D	Amber glass with Teflon-lined lid	Cool to 6° C	14 days until extraction 40 days after extraction
TPH (DRO)	3535A, 3540C, 3541, 3545A or 3550C with 8270D	Amber glass with Teflon-lined lid	Cool to 6° C	14 days until extraction 40 days after extraction
TPH (GRO)	5035 with 8015C	See Method for Requirements in SW 846		
TPH (Oil & Grease)	9071B	Wide-mouth glass container	Cool to 6° C	28 days

Analyte	Analytical Method	Container	Preservation	Holding Time
		with Teflon-lined lid		
Arsenic	6020A or 7010	Polyethylene or Glass	None	6 months
Barium	6010C or 6020A	Polyethylene or Glass	None	6 months
Cadmium	6010C, 6020A, or 7010	Polyethylene or Glass	None	6 months
Chromium	6010C or 6020A	Polyethylene or Glass	None	6 months
Lead	6010C, 6020A, or 7010	Polyethylene or Glass	None	6 months
Mercury	7471B	Polyethylene or Glass	None	28 days
Selenium	6020A or 7010	Polyethylene or Glass	None	6 months
Silver	6010C, 6020A, or 7010	Polyethylene or Glass	None	6 months
TCLP (metals)	1311	See Method for Requirements in SW 846		
Total Organic Carbon (TOC)	9060A	Polyethylene or Glass	Coot to 4° C	28 days

Appendix G: Leachability Model and Domenico Model

Leachability Model for Petroleum Contaminated Soils

The following approach is provided to determine whether leachates from petroleum contaminated soils will migrate to ground water and to determine Site Specific Target Levels (SSTLs) for cleanup of impacted soil. If soil concentrations are above the Risk Based Screening Levels (RBSLs) the soil leachability model can be used to determine if soil remediation is necessary. The model utilizes a series of mathematical equations that quantify contaminant partitioning, transport, degradation, and dilution processes. Please note that the Leachability Model should be used only when the separation distance is more than 8 feet.

Data Acquisition

Proper application of this model requires complete delineation of the horizontal and vertical extent of impacted soil and the analysis of representative soil samples. The Tier I Assessment provides guidelines for the number and locations of soil samples to be collected around the tanks, lines, and dispensers at a typical underground storage tank facility. If the horizontal and vertical extent of impacted soil has not been completely delineated during the Tier I assessment, additional samples should be collected during the Tier II Assessment (former Rapid Assessment). A complete soil assessment should include:

A. Installation of soil borings as explained below. No boring should be advanced below the water table.

1. Soil borings shall be advanced to the ground water * in the area occupied by the former or existing underground storage tanks, piping, and dispensers.

2. Soil borings shall be advanced to the ground water * adjacent to impacted borings to complete the full delineation.

3. Background Soil Boring : One soil boring shall be installed to a depth of 10 feet or to the ground water table, whichever is shallower, and at least thirty feet away from any USTs, product lines, dispensers, and other potential sources of CoC. If the site is too small to allow a separation of thirty feet, this soil boring shall be installed as far away from all USTs, product lines, dispensers, and other potential sources of CoC as possible. The soil sample must be collected from below the A-horizon unless a shallow water table precludes this.

* If the field screening results indicate that petroleum impact does not extend to the water table, the boring may be terminated after three consecutive clean split-spoon samples at five-foot intervals for the Tier I and Tier II Assessments or a boring to a depth of 50 feet for an Initial Ground Water Assessment. A soil sample shall be collected from the termination depth of that boring to verify the vertical extent of impacted soil. A second sample shall be collected from the depth interval that exhibits the highest concentration of impact. Both samples shall be analyzed by a South Carolina certified laboratory for appropriate CoC.

B. The lithology for each soil sample collected during boring installation shall be appropriately described. Samples shall be screened for organic vapors utilizing properly calibrated instruments. For other less volatile chemicals such as diesel or kerosene, alternative screening methods (e.g., field GC, immunoassay, etc.) can be used.

C. The soil sample from each boring around the USTs, piping, and dispensers shall be submitted to a Department certified laboratory for analyses as follows :

1. The sample (from each boring) with the highest organic vapor measurement shall be submitted to the laboratory for analysis. If the organic vapor measurements for all samples in a boring are within ten percent of each other, the sample from the greatest depth above the water table shall be submitted for analysis.
2. The samples (one from each soil boring) submitted to the laboratory shall be analyzed for the appropriate CoC.

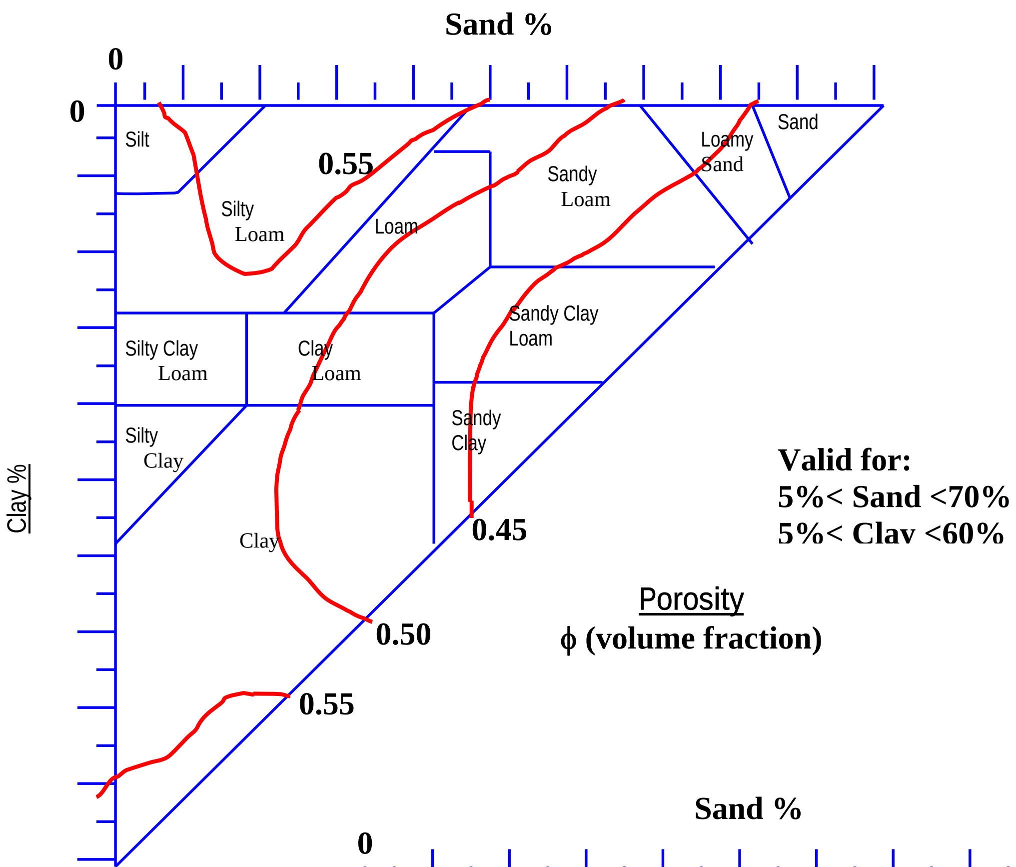


Figure G1

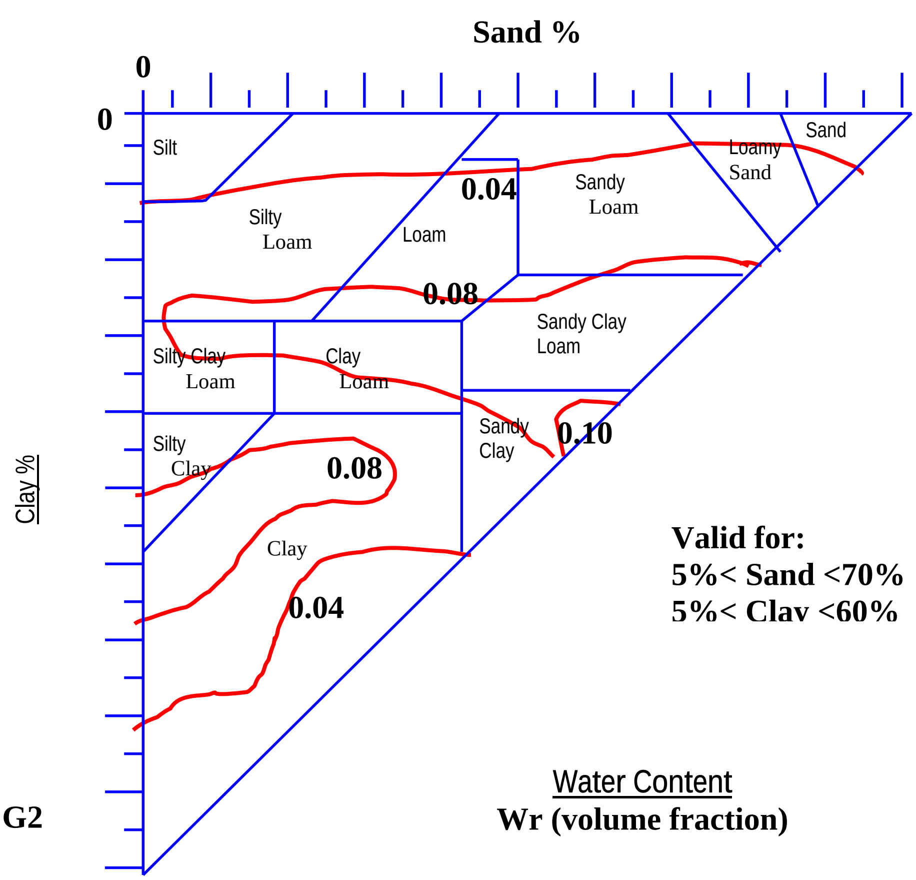


Figure G2

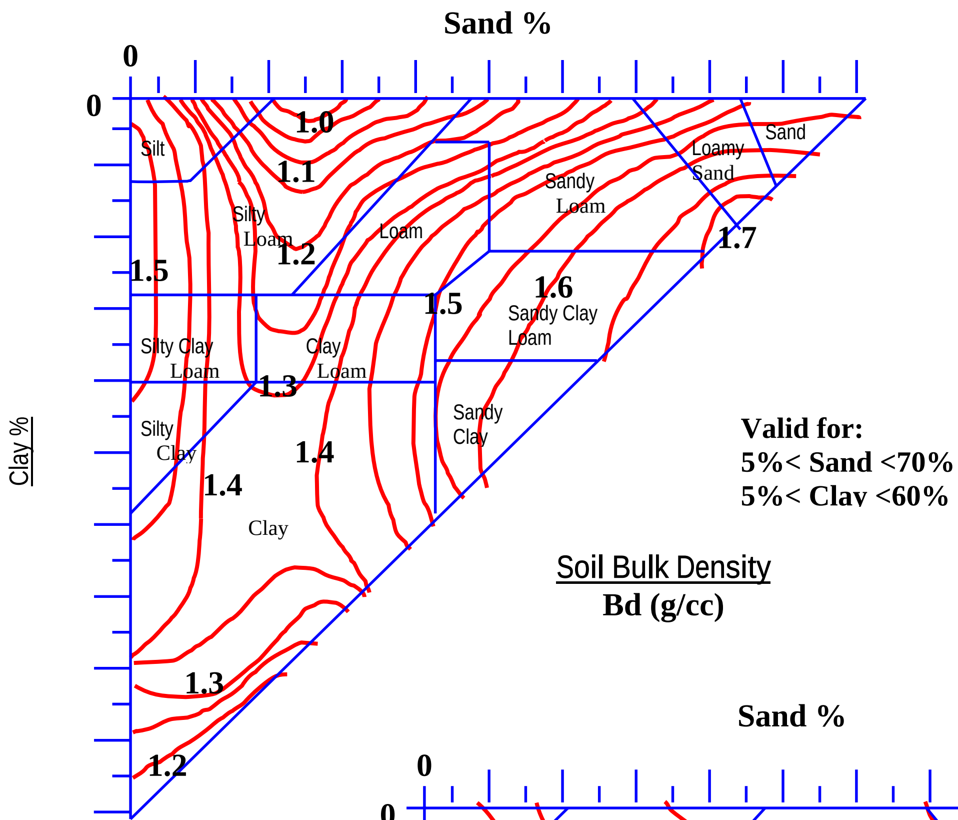


Figure G3

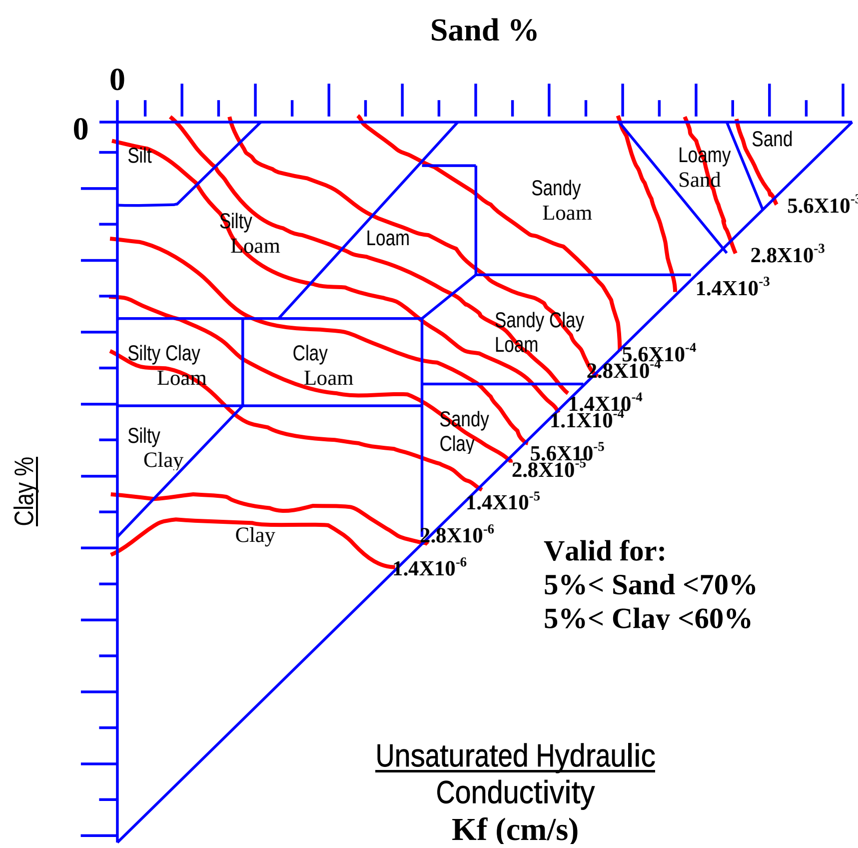


Figure G4

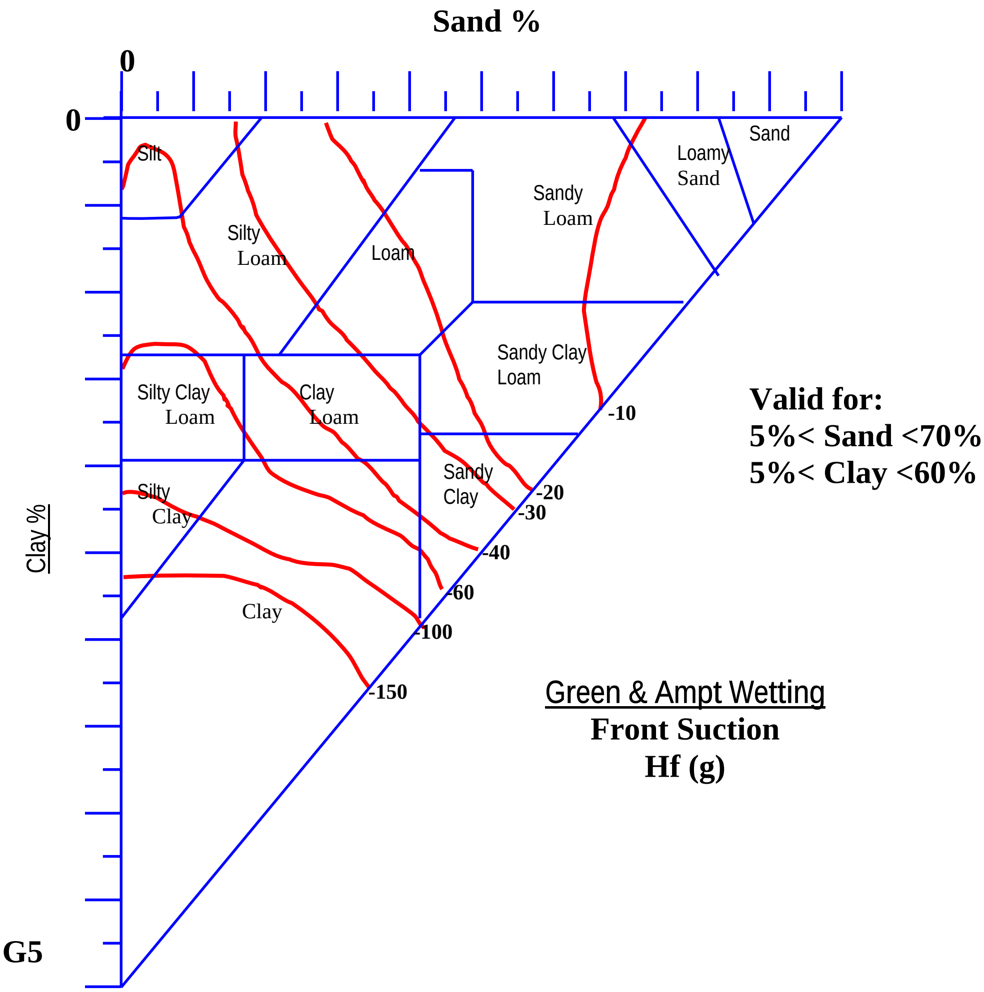


Figure G5

3. Soil samples shall be collected from the soil boring with the highest organic vapor measurement will be submitted for analyses in accordance with the Tier I Sampling Process Design.

4. The soil sample collected from the background soil boring shall be analyzed for total organic carbon (f_{oc}). The presence of calcareous soil shall be noted for possible analytical interferences. The presence of stained soil, peat beds, unusually high organic content, or other unusual conditions shall also be noted.

All soil borings must be properly abandoned pursuant to the South Carolina Well Standards and Regulations R.61-71.

SOIL LEACHABILITY MODEL INPUT PARAMETERS

The following input parameters are needed to utilize the equations. Forms for site specific input parameters and calculated results are provided which can be used to summarize the pertinent soil leachability input data, results and conclusions.

The following equations are valid for:

5% < Sand < 70%
5% < Clay < 60%

For sediments that are outside these ranges, the nearest maximum or minimum values should be used.

B_d Bulk density is defined as the weight of oven dry soil divided by the total volume of soils (solids +pores). Based on the grain size distribution, Bd can be estimated from Figure G3.

C_{rbsl} Risk based Screening Level (mg/L) for CoC in ground water. If appropriate, this can be substituted by the site specific target level for the CoC in ground water.

C_s Concentration of CoC (mg/Kg) in soil.

C_{sstl} Site Specific Target Level (mg/Kg) for chemical of concern in soil.

f_{oc} The natural organic content (mg/Kg) of uncontaminated background soil, typically determined by analysis of total organic carbon (TOC) by EPA Method 415.1. Naturally occurring TOC values in uncontaminated "B" and "C" horizon soils usually range from 100 to 1000 mg/Kg.

H' The Henry's Law Constant (mg/l)/(mg/l) relates the partial pressure of a gas and its corresponding solubility in water at a given temperature. Some averaged values for typical petroleum constituents are provided in Table G1.

H_f The wetting front suction head (cm) is the pressure head at the wetting front as it advances downward. Critical pressure head is always negative. Based on the grain size distribution, H_f can be estimated from Figure G5.

H_w Average annual recharge (precipitation minus evapotranspiration and runoff). Assume 25 centimeters unless additional information is available.

K_f Soil hydraulic conductivity (cm/s). Based on the grain size distribution, the field saturated hydraulic conductivity in the vadose zone can be estimated from Figure G4.

K_{oc} The soil/water partitioning coefficient (ml/g) is compound specific and provides an indication of the tendency of CoC to partition between particles containing organic carbon and water. Some averaged values for typical petroleum constituents are provided in Table G2. Please note that the values in Table G1 are most applicable for soils containing an f_{oc} value $\geq$ 1%.

L The separation distance (cm) between the depth of the soil sample exhibiting the highest concentration of CoC and the measured water table. For example, if the soil sample with the highest concentration of CoC occurred at 10 feet below land surface (bls) and ground water was encountered at 20 feet bls, then L = 10 feet = 304.8 cm.

N **Porosity** (decimal %) is the percentage of the rock or soil that is void of material. Based on the grain size distribution, the porosity can be estimated from Figure G1.

W_r **Residual water content** (decimal %) is the weight of the water remaining in the soil divided by the total weight of the soil sample. Based on the grain size distribution, the residual water content can be estimated from Figure G2.

$t_{½}$ The **biodegradation half-life period** (days) of CoC. This is compound specific. Some conservative values for typical petroleum constituents in vadose zone under anaerobic conditions are provided in Table G1.

Table G1
Chemical Specific Soil Data

CoC	K_{oc} * (ml/g)	H' (mg/l)/(mg/l)*	$t_{½}$ ** (days)
Benzene	81	0.226	16
Toluene	133	0.301	22
Ethylbenzene	176	0.280	10
Xylene	639	0.278	28
Naphthalenes	1543	0.002	48
Benzo(a)anthracene	1,380,384	0.0002	679
Benzo(b)fluoranthene	549,541	0.0005	610
Benzo(k)fluoranthene	4,365,158	0.043	2,139
Chrysene	245,471	3.02×0^{-18}	993
Dibenz(a,h)anthracene	1,659,587	3.05×10^{-7}	942

* From Montgomery. J.H. et.al., 1991, Groundwater Chemicals Desk Reference. Lewis Publishers.
** From Howard, P.H. et.al., 1991, Environmental Degradation Rates, Lewis Publishers.

Leachability model calculations consist of the following equation sets. Each set consists of several steps that should be used in calculating the different intermediate parameters.

Equation Set I

Determination of total organic carbon and air filled porosity

Step 1

Total organic carbon content (f_{cs}) (unitless) of the soil is calculated using the following equation:

where,

$$\mathbf{f_{cs}} = \left(\mathbf{f_{oc}} + \frac{\mathbf{TPH}}{\mathbf{1.724}} \right) \left(\mathbf{1x10^{-6}} \right)$$

f_{oc} is the natural organic carbon content (mg/Kg) of uncontaminated soil (see data acquisition section).
TPH is the Total Petroleum Hydrocarbon (mg/Kg).
1.724 is the conversion from organic matter to organic carbon fraction.
1×10^{-6} is the conversion from mg/Kg to decimal %.

Step 2

The air filled porosity (f) (decimal %) can be approximated using the following equation:

$f = \phi - W_r$

where,

ϕ is the porosity (decimal %) from Figure G1.
W_r is the residual water content (decimal %) from Figure G2.

Equation Set II

Determination of the velocity of the soil pore water (V_w)

Step 1

The infiltration rate of water through soil under constant head conditions (Green & Ampt equation as discussed in Bouwer, 1978) is determined. The result provides the time (t) it should take water to percolate through the vadose zone soil (from the depth of the worst case soil sample to the water table at the site).

$$\mathbf{t} = \left(\frac{\mathbf{f}}{\mathbf{K_f}} \right) * \left[\mathbf{L} - \left(\left\{ \mathbf{H_w} - \mathbf{H_f} \right\} * \left\{ \mathbf{ln} \frac{\mathbf{H_w} + \mathbf{L} - \mathbf{H_f}}{\left(\mathbf{H_w} - \mathbf{H_f} \right)} \right\} \right) \right]$$

where

f is the air filled porosity of soil (decimal %) calculated in Step 2 of Equation Set I.
K_f is the field saturated hydraulic conductivity (cm/s) which can be estimated from Figure G4.
L is the distance (cm) from the depth of the worst case soil sample to the water table.
H_w is the average annual recharge (cm), default value = 25 cm.
H_f is the Wetting front suction head (cm) which can be estimated from Figure G5.

Step 2

Taking the above calculated value for time (t) in seconds the velocity of the water (V_w) in feet per year is calculated using the following equation:

$$\mathbf{V_w} = \left(\frac{\mathbf{L}}{\mathbf{30.48}}\right) * \left(\frac{\mathbf{3.15 * 10^7}}{\mathbf{t}}\right)$$

where,

L is the distance (cm) from the depth of the worst case soil sample to the water table.
t is the time (s) required for water to travel distance L, calculated in Step 2.

<u>Equation Set III</u>

<u>Determination of the organic retardation effect (V_c) on the contaminant</u>

Step 1

The soil/water distribution coefficient (K_d) (ml/g) for uncontaminated soil is calculated using the following equation:

$K_d = K_{oc} * f_{oc} * (1 \times 10^{-6})$

where,

K_{oc} is the soil organic/water partitioning coefficient (ml/g) from Table G1.
f_{oc} is the natural organic carbon content (mg/Kg) of uncontaminated soil (see data acquisition section).
1×10^{-6} is the conversion from mg/Kg to decimal %.

Step 2

The retardation effect of natural soil organic matter on CoC migration is calculated using the following equation:

$$\mathbf{V_c} = \frac{\mathbf{V_w}}{\mathbf{1} + \left(\frac{\mathbf{Bd * Kd}}{\Phi}\right)}$$

where

V_c is the CoC percolation rate (ft/yr)

V_w is the water percolation rate (ft/yr) from Step 3 of Equation Set II.
B_d is the bulk density of soil (g/cc) from Figure G3.
K_d is the soil/water distribution coefficient (ml/g) calculated in Step 1.
ϕ is the porosity (decimal %) from Figure G1.

Equation Set IV

Determination of biodegradation rates and final CoC concentration (C_p) in the soil pore water necessary to protect ground water

Step 1

The following equation is used to calculate the time (days) required for the CoC to reach ground water using

$$\mathbf{T_c = \frac{365 * L}{30.48 * V_c}}$$

where,

L is the distance (cm) from the depth of the worst case soil sample to the water table.
V_c is the CoC percolation rate (ft/yr) as calculated in Step 2 of Equation Set III.

Step 2

CoC in the vadose zone are subject to several degradation and attenuation processes. This equation considers biodegradation in addition to the parameters of the previous equations. As attenuation processes such as dilution and volatilization are not accounted for in this equation, an estimate of the concentration (C_p) (mg/L) of CoC in the soil pore water necessary to protect ground water is calculated.

where,

$$\mathbf{\log(Cp) = \log(C_{GW_{sstl}}) + \left(\frac{Tc * 0.693}{2.303 * t_{1/2}}\right)}$$

C_{GWsstl} is the Site-Specific Target Level (mg/L) for CoC in ground water from groundwater fate and transport model or the Risk-based Screening Level as appropriate.
T_c is the time (days) for contaminant to percolate through the uncontaminated vadose zone soil and reach the ground water as calculated in Step 1 of Equation Set IV.
$t_{1/2}$ is the biodegradation half-life period of CoC (days) from Table G1.

Equation Set V

Determination of the Site Specific Target Levels for impacted soil

DILUTION/ATTENUATION FACTOR (DAF)

The Dilution/Attenuation Factor is a unitless number that expresses the magnitude of dilution and attenuation which occurs after the leachate generated from the soil encounters ground water.

Utilizing a Monte Carlo modeling approach, a range of typical site parameters were evaluated by the Department to determine appropriate Dilution / Attenuation Factors (DAF). Parameters that were considered include: hydraulic conductivity, hydraulic gradient, ground water recharge rates, dimensions of the impacted soil, and aquifer thickness. The following DAFs should be utilized as default values:

For Sandy Soil (hydraulic conductivity > 10^{-4} cm/sec)	DAF = 8
For Clay Soil (hydraulic conductivity $\leq 10^{-4}$ cm/sec)	DAF = 2

SITE SPECIFIC TARGET LEVEL (SSTL)

Determine the site specific target level of the CoC in soil. Equilibrium contaminant partitioning between sorbed and aqueous phases can be described by the following equation:

$$\mathbf{C_{sstl} = Cp * DAF * \frac{(Bd * Koc * fcs) + Wr + f * H'}{(Wr * 1g/cc + Bd)}}$$

where,

C_{Ssstl} is the Site Specific Target Level (mg/Kg) for the CoC in soil.

C_p is the concentration of the CoC in soil pore water (mg/L) calculated in Step 2 of Equation Set IV.

DAF is the Dilution/Attenuation Factor (unitless).

K_{oc} is the Soil organic/water partitioning coefficient (ml/g) from Table G1.

f_{cs} is the Total organic carbon content in decimal percent of the contaminated soil as calculated in Step 1 of Equation Set I.

f is the air filled porosity (decimal %) calculated in Step 2 of Equation Set I.

W_r is the residual water content (decimal %) from Figure G2.

1g/cc is the density of water.

B_d is the bulk density of the soil (g/cc) from Figure G3.

Leachability Input Parameters

South Carolina Department of Health and Environmental Control
Bureau of Land and Waste Management - Underground Storage Tank Program

Site Data

Facility Name: ____________________ UST Permit # __________

Input Parameters

Percent Sand in soil		________	%	5% < sand < 70%	
Percent Clay in soil		________	%	5% < clay < 60%	
DAF		________			
Worst Case Soil Analyses	Benzene	________	mg/Kg	C_s	
	Toluene	________	mg/Kg	C_s	
	Ethylbenzene	________	mg/Kg	C_s	
	Xylenes	________	mg/Kg	C_s	
	Naphthalene	________	mg/Kg	C_s	
	Other CoC	________	mg/Kg	C_s	
		________			
		________			
					Figure
Natural organic carbon content			mg/Kg	f_{oc}	
TPH			mg/Kg	TPH	
Porosity			decimal %	ϕ	G1
Residual water content			decimal %	W_r	G2
Bulk density of soil			g/cc	B_d	G3
Soil hydraulic conductivity			cm/sec	K_f	G4
Average annual recharge			cm	H_w	
Wetting front suction (negative number)			cm	H_f	G5
Distance from highest soil contamination to water table			cm	L	
Groundwater SSTL (or RBSL if appropriate)			mg/L	C_{GWsstl}	

List possible human exposure pathways from soil:

1 of ___ pages

Leachability Results and Conclusions

South Carolina Department of Health and Environmental Control
Bureau of Land and Waste Management – Underground Storage Tank Program

Site Data

Facility Name: ____ UST Permit #

Chemical of Concern (Benzene, Naphthalene, etc.) : ____
(Please use a separate form for each Chemical of Concern that exceeds the RBSL in soil.)

Chemical Specific Data

Biodegradation half-life period	days	$t_{1/2}$	Refer to
Soil/water partitioning coefficient	mg/L	K_{oc}	Table
Henry's law constant		H'	G1

Results

			Equation Set	Step
Total organic carbon content	decimal %	f_{cs}	I	1
Air filled porosity	decimal %	f	I	2
Infiltration time	seconds	t	II	1
Velocity of water	ft/yr	V_w	II	2
Soil/water distribution coefficient	ml/g	K_d	III	1
CoC percolation rate	ft/yr	V_c	III	2
Time to reach groundwater	days	T_c	IV	1
Concentration to protect groundwater	mg/L	C_p	IV	2
Site specific target level	mg/Kg	C_{Ssstl}	V	

Conclusions

Does concentration of CoC in soil exceed SSTL? Yes __________ No ______________

Risk of human exposure due to contaminated soil Yes __________ No ______________

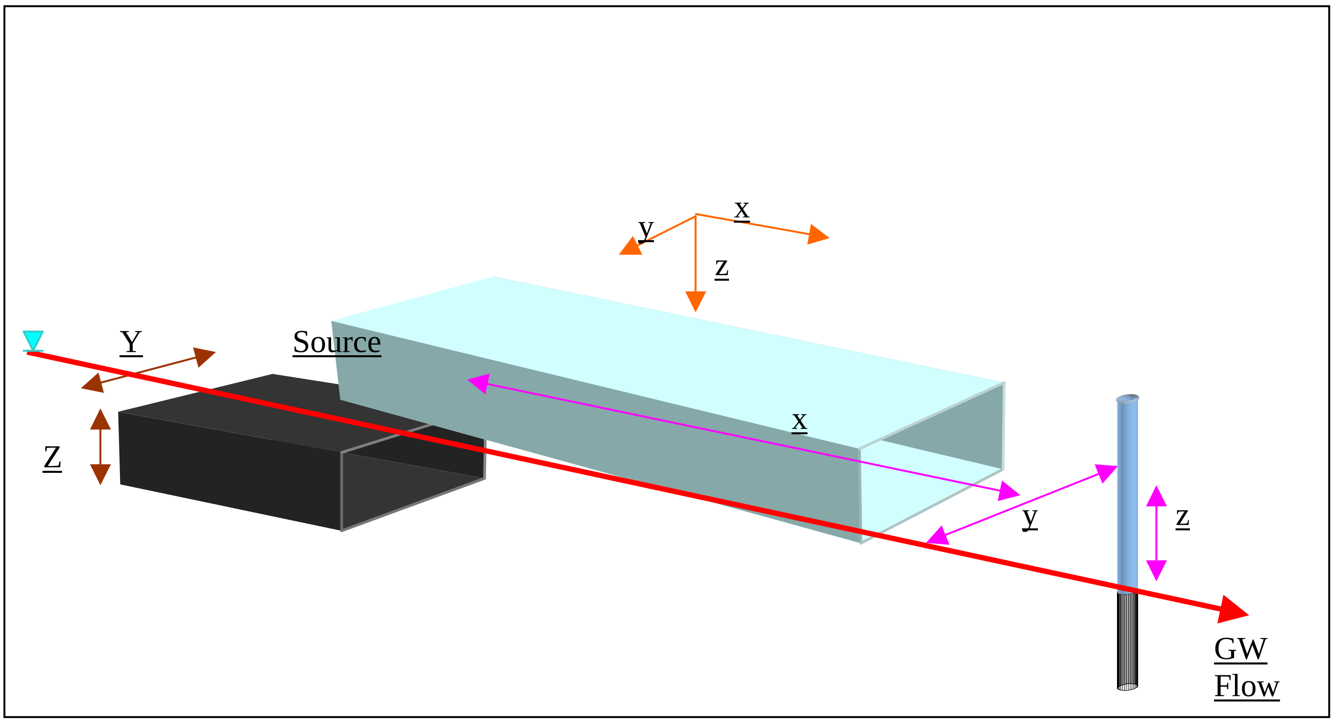
____ of ___ pages

Domenico's Model

Contaminant transport in the saturated or the unsaturated zone can be estimated using the **Domenico Model**. This analytical model utilizes three dimensional dispersion, seepage velocity, and biological degradation principles to predict the spatial and temporal decrease in concentration of CoC away from the source.

The Domenico Model (1987) is based on the following assumptions:

1) One dimensional flow and three dimensional (in two transverse directions and one vertical - downwards direction) dispersion;
2) The medium is isotropic and homogeneous;
3) The source concentration is constant;
4) The areal source is perpendicular to the direction of flow; and
5) decay of the contaminant in the dissolved and adsorbed phases occurs at the same rate resulting in a first order decay rate.



EQUATION 1

This is the general form of the Domenico's Equation. In this equation, the effects of three-dimensional dispersion, one-dimensional uniform flow in the x-direction are considered. The source is considered to be a constant concentration (infinite-mass) areal source of dimension Y and Z (as shown in the Figure D1).

$$\mathbf{C}(x,y,z,t)=\left(\frac{\mathbf{C_0}}{\mathbf{8}}\right)*\exp\left[\left(\frac{x}{2\alpha_x}\right)\left(1-\sqrt{1+\frac{4\lambda\alpha_x}{v}}\right)\right]*\boldsymbol{erfc}\left[\frac{\mathrm{x}-\mathrm{vt}\sqrt{1+\frac{4\lambda\alpha_x}{v}}}{2\sqrt{\alpha_x vt}}\right]*$$

$$\left\{\boldsymbol{erf}\left[\frac{\mathbf{y}+\frac{\mathbf{Y}}{\mathbf{2}}}{2\sqrt{\alpha_y x}}\right]-\boldsymbol{erf}\left[\frac{\mathbf{y}-\frac{\mathbf{Y}}{\mathbf{2}}}{2\sqrt{\alpha_y x}}\right]\right\}*\left\{\boldsymbol{erf}\left[\frac{\mathbf{z}+\mathbf{Z}}{2\sqrt{\alpha_z x}}\right]-\boldsymbol{erf}\left[\frac{\mathbf{z}-\mathbf{Z}}{2\sqrt{\alpha_z x}}\right]\right\}$$

where

C_0 is the Concentration of CoC at source (mg/l)
Y is the width of source perpendicular to GW flow (m)
Z is the vertical thickness of source (m)
x is the distance from source to receptor (x-coordinate) (m)
y is the y coordinate of the receptor relative to source (m)
z is the z coordinate of the receptor relative to source (m)
α_x is the longitudinal dispersivity (m) (x/10)
α_y is the transverse dispersivity (m) (α_x/3)
α_z is the vertical dispersivity (m) (α_x/20)
v is the contaminant velocity (m/s)*
erf is the error function**
erfc is the complimentary error function**
λ is the first order decay rate (1/sec)***
t is the time during which contaminant transport takes place (sec)

* If the CoC adsorbs, the contaminant velocity (v) is replaced by the retarded velocity (v/R), where R is the retardation factor in the saturated zone. The Retardation factor can be calculated with the following equation:

$$\mathbf{R} = \mathbf{1} + \frac{\mathbf{K_{oc} * F_{oc} * B_d * 10^{-6}}}{\Phi}$$

where,

K_{oc} is the chemical specific soil/water partitioning coefficient (ml/g) derived from literature.
f_{oc} is the naturally occurring organic carbon (mg/Kg) in soil measured in the saturated zone.
B_d is the Bulk Density (gm/cc).
ϕ is the porosity (decimal %).

** The Error Function and Complimentary Error Function are dimensionless numbers that can be derived from an erf and erfc table. These tables can be found in many hydrogeology textbooks (e.g., Fetter, 1988) .

Please note that: erfc(x) = 1- erf (x); erf(-x) = -erf(x); and erfc(-x) = 1 + erf(x).

*** If the first order decay rates have not been determined on a site-specific basis, the decay rate (λ) shall be assumed to be 0. Site-specific values can be evaluated on the basis of temporal and spatial variation of the CoCs.

EQUATION 2

If the receptor is not located along the x-axis centerline, y and z$\neq$0 and λ= 0.

$$\mathbf{C}(\boldsymbol{x, y, z, t}) = \left(\frac{\mathbf{C_0}}{\mathbf{8}}\right) * \boldsymbol{erfc}\left[\frac{(\mathrm{x} - \mathrm{vt})}{2\sqrt{\alpha_x \boldsymbol{vt}}}\right] * \left\{\boldsymbol{erf}\left[\frac{\mathbf{y} + \frac{\mathbf{Y}}{\mathbf{2}}}{2\sqrt{\alpha_y \boldsymbol{x}}}\right] - \boldsymbol{erf}\left[\frac{\mathbf{y} - \frac{\mathbf{Y}}{\mathbf{2}}}{2\sqrt{\alpha_y \boldsymbol{x}}}\right]\right\} * \left\{\boldsymbol{erf}\left[\frac{\mathbf{z} + \mathbf{Z}}{2\sqrt{\alpha_z \boldsymbol{x}}}\right] - \boldsymbol{erf}\left[\frac{\mathbf{z} - \mathbf{Z}}{2\sqrt{\alpha_z \boldsymbol{x}}}\right]\right\}$$

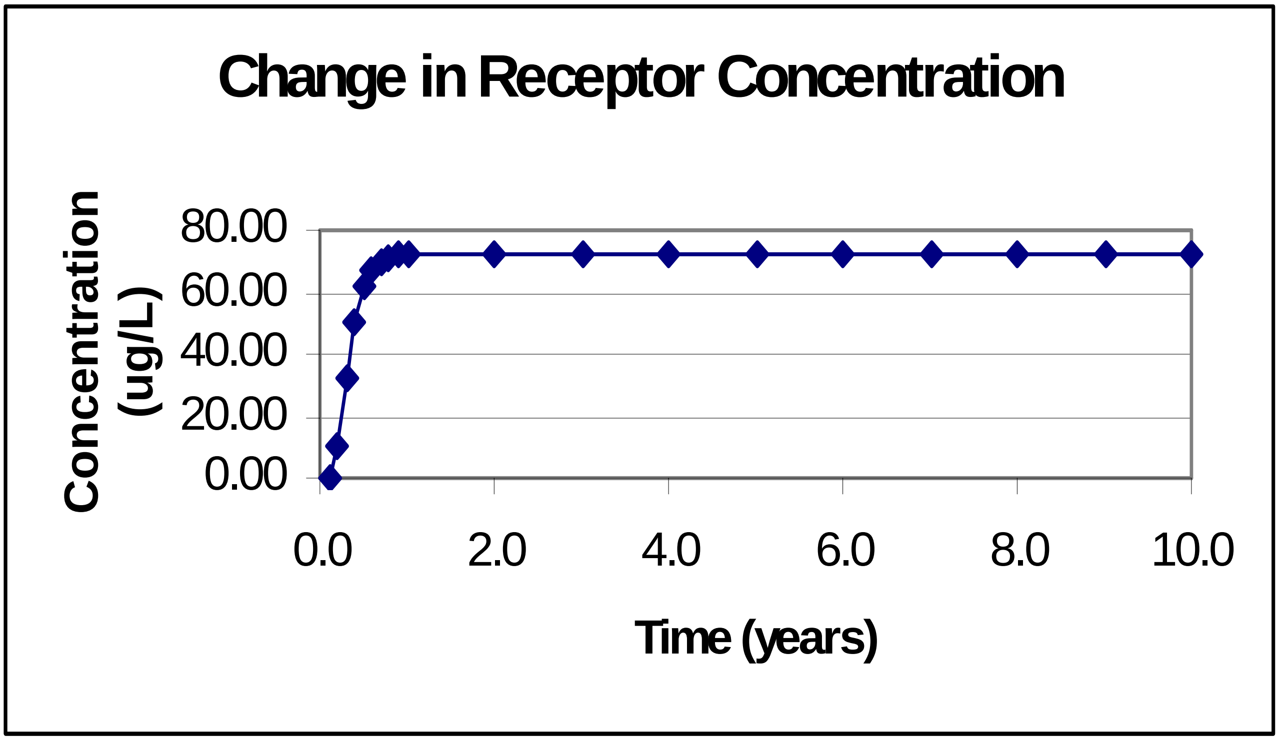
EQUATION 3

Equation 3 should be used if the receptor is located along the centerline (x- axis) and hydraulically down-gradient of the source. In that case, y = z = 0 and λ = 0.

$$\mathbf{C}(\boldsymbol{x,0,0,t}) = \left(\frac{\mathbf{C_0}}{\mathbf{2}}\right) * \boldsymbol{erfc}\left[\frac{(\mathrm{x} - \mathrm{vt})}{2\sqrt{\alpha_x \boldsymbol{vt}}}\right] * \boldsymbol{erf}\left[\frac{\mathbf{Y}}{4\sqrt{\alpha_y \boldsymbol{x}}}\right] * \boldsymbol{erf}\left[\frac{\mathbf{Z}}{2\sqrt{\alpha_z \boldsymbol{x}}}\right]$$

Variation of a CoC with time is according to an exponential relationship. Figure D2 shows the change in the CoC concentrations for a source of C_0=2 mg/L and with dimensions Y=10m, Z=3m, x=100m, and Vs=1E^{-5}m/s; λ =0 /s. The concentrations for the time t=0 to 10 years were calculated and are tabulated as shown. Based on the graph, we see that the CoC concentrations increase as the time increases, becoming asymptotic at a value of 72.48 μg/L. From this graph, it can be seen that the maximum concentration of 72.48 μg/L can be reached at the receptor for the given continuous source and hydrological conditions after five years.
Data calculated to be used in this example are given in the table below.

Figure D2



Time (Year)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
CoC Conc.(μ/L)	0.16	10.7	32.6	50.6	61.6	67.4	70.2	71.5	72.1	72.3	72.4	72.4	72.5	72.5	72.5	72.5	72.5	72.5	72.5

<u>SSTL CALCULATIONS</u>

Using the Domenico's model, one can calculate the SSTLs for a given source and receptor configuration for each CoC. Knowing the RBSL for a given receptor, the inverse of the Domenico's equation can be used to calculate the SSTL.

The following equation can be used.

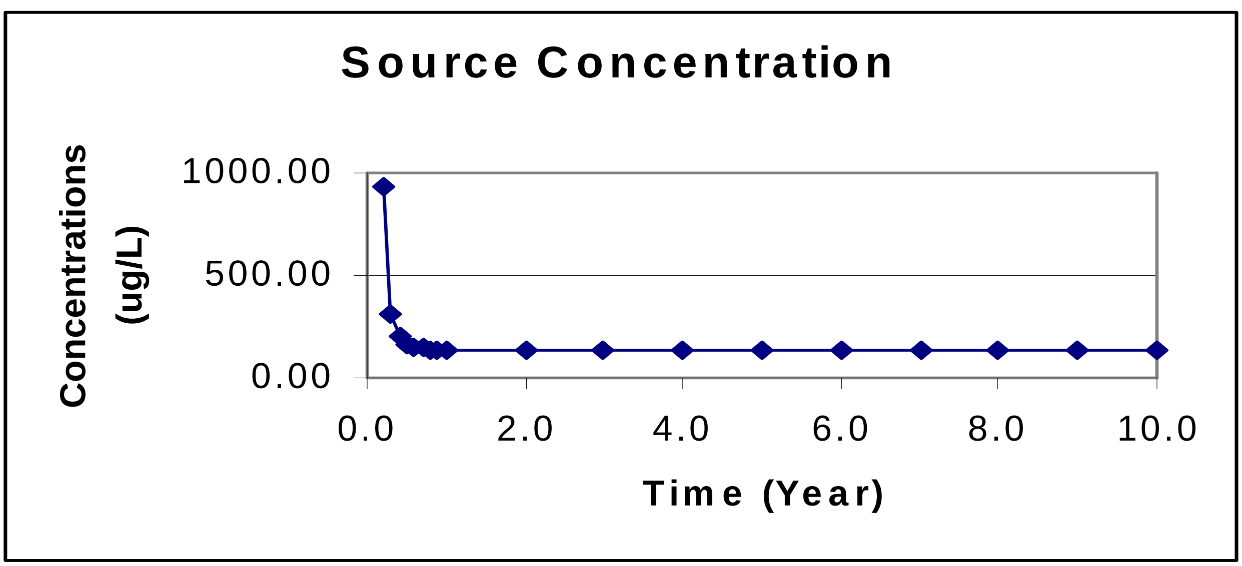
$$Csstl = \frac{8*Crbsl}{\exp\left[\left(\frac{x}{2\alpha_x}\right)\left(1-\sqrt{1+\frac{4\lambda\lambda_x}{v}}\right)\right]*\operatorname{erfc}\left[\frac{x-vt\sqrt{1+\frac{\lambda\alpha_x}{v}}}{2\sqrt{\alpha_x vt}}\right]*\left\{\operatorname{erf}\left[\frac{y+\frac{Y}{2}}{2\sqrt{\alpha_y x}}\right]-\operatorname{erf}\left[\frac{y-\frac{Y}{2}}{2\sqrt{\alpha_y x}}\right]\right\}*\left\{\operatorname{erf}\left[\frac{z+Z}{2\sqrt{\alpha_z x}}\right]-\operatorname{erf}\left[\frac{z-Z}{2\sqrt{\alpha_z x}}\right]\right\}}$$

where

C_{rbsl} is the RBSL concentration for the selected CoC.

Figure D3 shows the change in the CoC concentrations for a source of Y= 10m; Z=3m , x=100m, Vs=1E-5m/s and λ=0 /s. The source concentrations are calculated for a t=0 to 10 years and are plotted as shown. Based on the graph, we can see that the CoC concentrations decrease as the time increases, becoming asymptotic at a value of 137.98 μg/L. From this graph, it can be seen that the minimum SSTL can be established to be at a concentration of 137.98 μg/L after 0.9 year. The data are given in the table below.

Figure D3



Time (year)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
CoC Conc.(μ/L)		936	306	197	162	148	142	139	138	138	138	138	138	138	138	138	138	138	138

Appendix H: Standard Field Cleaning Procedures

STANDARD FIELD CLEANING PROCEDURES

Introduction

Cleaning procedures in this appendix are intended for use by field personnel for cleaning sampling and other equipment in the field. Emergency field sample container cleaning procedures are also included; however, they should not be used unless absolutely necessary. Deviations from these procedures should be documented in the approved study plan, field records, and investigative reports.

These are the materials, methods, and procedures to be used when cleaning sampling and other equipment in the field.

Caution – Exercise care when working with flammable solvents! Avoid any activity that would produce sparks or excess heat. Avoid hazardous atmospheres.

Specifications for Cleaning Materials:

Specifications for standard cleaning materials referred to in this appendix are as follows:

- Soap shall be a standard brand of phosphate-free laboratory detergent such as Liquinox. Use of other detergent must be justified and documented in the field logbooks and inspection or investigative reports. The use of Luminox detergent may remove the need to rinse with pesticide –grade isopropanol.
- Solvent shall be pesticide-grade isopropanol. Use of a solvent other than pesticide-grade isopropanol for equipment cleaning purposes must be justified in the study plan.
- Tap water may be used from any municipal water treatment system.
- Analyte free water (deionized water) is tap water that has been treated by passing through a standard deionizing resin column and followed by an activated carbon column.
- Other solvents may be substituted for a particular purpose if required. For example, removal of concentrated waste materials may require the use of either pesticide-grade hexane or petroleum ether. After the waste material is removed, the equipment must be subjected to the standard cleaning procedure. Because these solvents are not miscible with water, the equipment must be completely dry prior to use.

Solvents, laboratory detergent, and rinse waters used to clean equipment shall not be reused during field decontamination.

Handling and Containers for Cleaning Solutions:

Improperly handled cleaning solutions may easily become contaminated. Storage and application containers must be constructed of the proper materials to ensure their integrity. Following are acceptable materials used for containing the specified cleaning solutions:

- Soap must be kept in clean plastic, metal, or glass containers until used. It should be poured directly from the container during use.

- Solvent must be stored in the unopened original containers until used. They may be applied using a Teflon® squeeze bottles.

- Tap water may be kept in clean tanks, squeeze bottles, or applied directly from a hose.

- Analyte free water must be stored in clean glass, stainless steel, or plastic containers that can be closed prior to use. It can be applied from plastic squeeze bottles.

Disposal of Solvent Cleaning Solutions:
Procedures for the safe handling and disposition of investigation derived waste (IDW), including used wash water, rinse water, and spent solvents must be specified in the QAPP Addendum.

Equipment Contaminated with Concentrated Wastes:
Equipment used to collect samples of hazardous materials or toxic wastes or materials from hazardous waste sites, RCRA facilities, or in-process waste streams should be field cleaned before returning from the study. At a minimum, this should consist of washing with soap and rinsing with tap water. More stringent procedures may be required at the discretion of the field investigators.

Safety Procedures for Field Cleaning Operations:
Some of the materials used to implement the cleaning procedures outlined in this appendix can be harmful if used improperly. Caution should be exercised by all field investigators and all applicable safety procedures should be followed. At a minimum, the following precautions should be taken in the field during these cleaning operations:

- Safety glasses with splash shields or goggles, and nitrile gloves should be worn during all cleaning operations.
- Solvent rinsing operations will be conducted in the open (never in a closed room).
- No eating, smoking, drinking, chewing, or any hand to mouth contact should be permitted during cleaning operations.

Handling of Cleaned Equipment:
After field cleaning, equipment should be handled only by personnel wearing clean gloves to prevent re-contamination. In addition, the equipment should be moved away (preferably upwind) from the cleaning area to prevent recontamination. If the equipment is not to be immediately re-used it should be covered with plastic sheeting or wrapped in aluminum foil to prevent re-contamination. The area where the equipment is kept prior to re-use must be free of contaminants.

Field Equipment Cleaning Procedures

Sufficient clean equipment should be transported to the field so that an entire study can be conducted without the need for field cleaning. However, this is not possible for some items such as portable power augers (Little Beaver®), well drilling rigs, soil coring rigs, and other large pieces of field equipment. In addition, particularly during large scale studies, it is not practical or possible to transport all of the pre-cleaned field equipment required into the field. In these instances, sufficient pre-cleaned equipment should be transported to the field to perform at least one days work. The following procedures are to be utilized when equipment must be cleaned in the field.

Specifications for Decontamination Pads

Decontamination pads constructed for field cleaning of sampling and drilling equipment should meet the following minimum specifications:

- The pad should be constructed in an area known or believed to be free of surface contamination.
- The pad should not leak excessively.

- If possible, the pad should be constructed on a level, paved surface and should facilitate the removal of wastewater. This may be accomplished by either constructing the pad with one corner lower than the rest, or by creating a sump or pit in one corner or along one side. Any sump or pit should also be lined.
- Sawhorses or racks constructed to hold equipment while being cleaned should be high enough above ground to prevent equipment from being splashed.
- Water should be removed from the decontamination pad frequently.
- A temporary pad should be lined with a water impermeable material with no seams within the pad. This material should be either easily replaced (disposable) or repairable.

At the completion of site activities, the decontamination pad should be deactivated. The pit or sump should be backfilled with the appropriate material designated by the site project leader, but only after all waste/rinse water has been pumped into containers for disposal. No solvent rinsates will be placed in the pit. Solvent rinsates should be collected in separate containers for proper disposal. If the decontamination pad has leaked excessively, soil sampling may be required.

"Classic Parameter" Sampling Equipment:

"Classic Parameters" are analyses such as oxygen demand, nutrients, certain inorganics, sulfide, flow measurements, etc. For routine operations involving classic parameter analyses, water quality sampling equipment such as Kemmerers, buckets, dissolved oxygen dunkers, dredges, etc., may be cleaned with the sample or analyte-free water between sampling locations. A brush may be used to remove deposits of material or sediment, if necessary. If analyte-free water is used samplers should be flushed at the next sampling location with the substance (water) to be sampled, but before the sample is collected.

Flow measuring equipment such as weirs, staff gauges, velocity meters, and other stream gauging equipment may be cleaned with tap water between measuring locations, if necessary.

NOTE: The previously described procedures are not to be used for cleaning field equipment to be used for the collection of samples undergoing trace organic or inorganic constituent analyses.

Sampling Equipment used for the Collection of Trace Organic and Inorganic Compounds:

The following procedures are to be used for all sampling equipment used to collect routine samples undergoing trace organic or inorganic constituent analyses:

1. Clean with tap water and soap using a brush if necessary to remove particulate matter and surface films. Equipment may be steam cleaned (soap and high pressure hot water) as an alternative to brushing. Sampling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. PVC or plastic items should not be steam cleaned.
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with analyte free water.
4. Rinse thoroughly with solvent. Do not solvent rinse PVC or plastic items.
5. Remove the equipment from the decontamination area and cover with plastic. Equipment stored overnight should be wrapped in aluminum foil and covered with clean, unused plastic., or hermetically seal in an appropriately sized polyethylene bag.

Well Sounders or Tapes:

1. Wash with soap and tap water.
2. Rinse with tap water.
3. Rinse with analyte free water. (Do not solvent rinse PVC or plastic items.)

Fultz Pump Cleaning Procedure:

CAUTION - To avoid damaging the Fultz pump:

- Never run pump when dry
- Never switch directly from the forward to the reverse mode without pausing in the "OFF" position

The Fultz® pump should be cleaned prior to use and between each monitoring well. The following procedure is required:

1. Pump a sufficient amount of soapy water through the hose to flush out any residual purge water.
2. Using a brush, scrub the exterior of the contaminated hose and pump with soapy water. Rinse the soap from the outside of the hose with tap water. Rinse the hose with analyte-free water and recoil onto the spool.
3. Pump a sufficient amount of tap water through the hose to flush out all the soapy water (approximately one gallon).
4. Pump a sufficient amount of analyte-free water through the hose to flush out the tap water, then purge with the pump in the reverse mode.
5. Rinse the outside of the pump housing and hose with analyte-free water (approximately 1/4 gal.).
6. Place pump and reel in clean plastic bag.

Peristaltic Pump Cleaning Procedure:

CAUTION - During cleaning always disconnect the pump from the generator.

The peristaltic pump should be cleaned prior to use and as necessary between each use.

The following procedure is required:

1. Using a brush, scrub the exterior of the contaminated hose and pump with soap and tap water.
2. Rinse the soap from the outside of the pump and hose with tap water.
3. Rinse the tap water residue from the outside of pump and hose with analyte-free water.
4. Allow the pump to dry prior to use.

Redi-Flo2 Pump:

The Redi-Flo2 pump should be cleaned prior to use and between each monitoring well. The following procedure is required:

CAUTION - Make sure the pump is not plugged in.

1. Using a brush, scrub the exterior of the pump, electrical cord and garden hose with soap and tap water. Do not wet the electrical plug.
2. Rinse with tap water.
3. Rinse with analyte free water.
4. Place the equipment in a clean plastic bag.

To clean the Redi-Flo2 ball check valve:

1. Completely dismantle ball check valve. Check for wear and/or corrosion, and replace as needed.
2. Using a brush, scrub all components with soap and tap water.
3. Rinse with analyte free water.
4. Reassemble and re-attach the ball check valve to the Redi-Flo2 pump head.

Automatic Sampler Tubing:

The Silastic and Tygon tubing previously used in the automatic samplers may not be reused. All tubing must be replaced with new tubing.

Downhole Drilling Equipment

These procedures are to be used for drilling activities involving the collection of soil samples for trace organic and inorganic constituent analyses, and for the construction of monitoring wells to be used for the collection of groundwater samples for trace organic and inorganic constituent analyses.

Introduction:

Cleaning and decontamination of all equipment should occur at a designated area (decontamination pad) on the site. The decontamination pad should meet the specifications of the *Specifications for Decontamination Pads Section* of this Appendix.

Tap water (potable) brought on the site for drilling and cleaning purposes should be contained in a pre-cleaned tank of sufficient size so that drilling activities can proceed without having to stop and obtain additional water.
A steam cleaner and/or high pressure hot water washer capable of generating a pressure of at least 2500 PSI and producing hot water and/or steam (200°F plus), with a soap compartment, should be obtained.

Preliminary Cleaning and Inspection:

The drill rig should be clean of any contaminants that may have been transported from another hazardous waste site, to minimize the potential for cross-contamination. Further, the drill rig itself should not serve as a source of contaminants. In addition, associated drilling and decontamination equipment, well construction materials, and equipment handling procedures should meet these minimum specified criteria:

- All downhole augering, drilling, and sampling equipment should be sandblasted before use if painted, and/or there is a buildup of rust, hard or caked matter, etc., that cannot be removed by steam cleaning (soap and high pressure hot water), or wire brushing. Sandblasting should be performed prior to arrival on site, or well away from the decontamination pad and areas to be sampled.

- Any portion of the drill rig, backhoe, etc., that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned (soap and high pressure hot water) and wire brushed (as needed) to remove all rust, soil, and other material which may have come from other hazardous waste sites before being brought on site.

- Printing and/or writing on well casing, tremie tubing, etc., should be removed before use. Emery cloth or sand paper can be used to remove the printing and/or writing. Most well material suppliers can supply materials without the printing and/or writing if specified when ordered.

- The drill rig and other equipment associated with the drilling and sampling activities should be inspected to insure that all oils, greases, hydraulic fluids, etc., have been removed, and all seals and gaskets are intact with no fluid leaks.

- PVC or plastic materials such as tremie tubes should be inspected. Items that cannot be cleaned are not acceptable and should be discarded.

Drill Rig Field Cleaning Procedure:

Any portion of the drill rig, backhoe, etc., that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned or cleaned with soap and high pressure water between boreholes.

Field Cleaning Procedure for Drilling Equipment:

The following is the standard procedure for field cleaning augers, drill stems, rods, tools, and associated equipment. This procedure does not apply to well casings, well screens, or split-spoon samplers used to obtain samples for chemical analyses, which should be cleaned as outlined in Section B.2.3.

1. Clean with tap water and soap, using a brush if necessary, to remove particulate matter and surface films. Steam cleaning or cleaning with high pressure water with soap may be necessary to remove matter that is difficult to remove with the brush. Drilling equipment that is steam cleaned should be placed on racks or saw horses above the ground. Hollow-stem augers, drill rods, etc., that are hollow or have holes that transmit water or drilling fluids, should be cleaned on the inside with vigorous brushing.
2. Rinse thoroughly with tap water.
3. Remove from the decontamination pad and cover with clean, unused plastic. If stored overnight, the plastic should be secured to ensure that it stays in place.

When there is concern for low-level contaminants it may be necessary to clean this equipment between borehole drilling and/or monitoring well installation using the procedure outlined in the *Sampling Equipment used for the Collection of Trace Organic and Inorganic Compounds Section* of this Appendix.

Emergency Disposable Sample Container Cleaning

New one-pint or one-quart glass mason jars may be used to collect samples for analyses of organic compounds and metals in waste and soil samples during an emergency. In the case of chemicals that adhere to glass, PPE or HDPE mason jars may be used to collect samples. These containers would also be acceptable on an emergency basis for the collection of water samples for extractable organic compounds, pesticides, and metals analyses. These jars cannot be used for the collection of water samples for volatile organic compound analyses.

The rubber sealing ring should not be in contact with the jar and aluminum foil should be used, if possible, between the jar and the sealing ring. If possible, the jar and aluminum foil should be rinsed with pesticide-grade isopropanol and allowed to air dry before use. Several empty bottles and lids should be submitted to the laboratory as blanks for quality control purposes.

Appendix I: Pump Operating Procedures

PUMP OPERATING PROCEDURES

Peristaltic Pump

1.1 Introduction:
When relatively small volumes of water are required for purging and sampling, and the water level is within the limit of suction (generally around 25 feet vertical separation between the pump and water surface) peristaltic pumps can be used. These pumps are generally small, light-weight, and portable and are powered by 12-volt batteries.
The application of these pumps differs with respect to purging and sampling. The following sections detail the use of peristaltic pumps for both purposes.

1.2 Purging with a Peristaltic Pump:
l. Place a coil of standard-cleaned (Appendix B) tubing of appropriate composition, equal to the well depth plus an additional five to ten feet, in a standard cleaned bucket or box which has been lined with clean plastic sheeting or a garbage bag. Enough tubing is needed to run from the ground surface up to the top of the well casing and back down to the bottom of the well. This will allow for operation of the pump at all possible water level conditions in the well.
2. Place one end of the tubing into the vacuum side of the peristaltic pump head. Proper sizing of the tubing should allow for a snug fit of the Teflon® tubing inside the flexible tubing mounted in the pump head.
3. Run a short section of tubing from the discharge side of the pump head to a graduated bucket.
4. Place the free end of the coil of tubing into the well until the end of the tubing is just below the top of the water column.
5. Secure the tubing to the well casing or other secure object using electrician's tape or other suitable means. This will prevent the tubing from being lost in the well should all of the tubing be deployed and come loose from the pump head.
6. Turn on the pump to produce a vacuum on the well side of the pump head and begin the purge. Observe pump direction to ensure that a vacuum is being applied to the purge line. If the purge line is being pressurized, either switch the tubing at the pump head or reverse the polarity of the cables on the pump or on the battery.
7. Purge the well according to the criteria described in Section 7.2 of this manual. If the pumping rate exceeds the recovery rate of the well, continue to lower the tubing into the well several feet at a time, as needed, until the drawdown stabilizes or the well is evacuated to dryness. If the pump is a variable speed peristaltic pump, and the water level in the well is being drawn down, reduce the speed of the pump in an attempt to stabilize the drawdown. If the well can be purged without evacuating the well to dryness, a sample with greater integrity can be obtained.
8. For wells, which are not evacuated to dryness, particularly those with recovery rates equal to or very nearly equal to the purge rate, there may not be a complete exchange and removal of stagnant water in that portion of the water column above the tubing intake. For this reason, it is important that the tubing intake be placed in the very uppermost portion of the water column while purging. Standard field measurements should frequently be taken during this process to verify adequacy of the purge.

1.3 Sampling with a Peristaltic Pump:
Flexible tubing used in peristaltic pump heads is not acceptable for collecting samples for organic compounds analyses and cannot easily be field cleaned between sampling locations prior to collecting samples for other parameters. For these reasons, it is necessary to use a vacuum container, placed between the pump and the well for sample collection with a peristaltic pump. However, if the flexible pump tubing is decontaminated, samples for analyses of some inorganic constituents may be collected through the tubing if blanks are collected. This method is detailed in the following steps.
NOTE: Samples for volatile organic compound analyses cannot be collected using this method. If samples for VOC analyses are required, they must be collected with a Teflon® or stainless steel bailer or by other approved methods, such as the straw method. The straw method involves allowing the tubing to fill, by either lowering it into the water column or filling it via suction applied by the pump head. Upon filling, the tubing is removed from the well and allowed to drain into the sample vial. This is repeated, as necessary, until all vials are filled.
1. Disconnect the purge tubing from the pump. Make sure the tubing is securely attached to the protective casing or other secure object.
2. Insert the tubing into one of the ferrule nut fittings of a Teflon® vacuum container transfer cap assembly.

3. Place a suitable length of tubing (Teflon® if for VOCs) between the remaining transfer cap assembly ferrule nut fitting and the vacuum side of the flexible tubing in the peristaltic pump head. Securely hand tighten both fittings.
4. Turn the pump on. Water should begin to collect in the transfer container (typically a 4-liter or 1-gallon sample container) within a few minutes. If water does not begin to flow into the container within five minutes, check the transfer cap fittings and make sure the assembly is tightly attached to the container. It may be necessary to tighten the ferrule nuts with a wrench or pliers to achieve a vacuum in the system, particularly when approaching the maximum head difference between the pump and water table.
5. When the transfer container is nearly full, turn off the pump, remove the transfer cap assembly, and pour the sample into the appropriate containers. Samples to be analyzed for extractable organic compounds, metals, and cyanide can be collected using this system.
6. If additional sample volume is needed, replace the transfer cap assembly, turn the pump on, and collect additional volume. The use of Teflon® valves or ball check devices to retain the water column in the sample delivery tubing during the transfer phase, when large volumes of sample are required, is acceptable. These devices, however, must be constructed so that they may be completely disassembled and cleaned.
7. When sampling is completed, all Teflon® tubing should be discarded.

Fultz Pump

<u>2.1 Introduction:</u>
The Fultz pump is a small 24-volt DC submersible pump suitable for purging most 2-inch and some 4-inch wells and is available in two different diameters, 1.75 inches and 2.5 inches. Operating depths for these pumps range from approximately 135 feet to 150 feet. Maximum pump rates range from approximately 1.5 gallons per minute, at shallower depths, to less than 0.5 gallon per minute at the maximum operating depth. For a given depth, the 2.5-inch pump has a slightly higher pumping rate, than smaller diameter pump. The pump housing for each pump is constructed of 304 stainless steel and houses a high efficiency electric motor and Teflon® gears (rotors). Water is pulled through a fine-mesh stainless steel screen on the pump head by the meshing rotors and is positively displaced through the discharge hose.
As supplied from the manufacturer, power for the pump is supplied by an internal power pack comprised of four 6-volt gel cell batteries. The manufacturer also offers an external power pack, containing the same array of batteries as the internal supply, and a 24-volt DC generator as optional power sources. It has been found that the pumps operate at higher rates and for longer periods of time when powered either with the generator or with two 12-volt car or motorcycle batteries connected to provide 24 volts.

<u>2.2 Operation:</u>
<u>Control Panel Switch Functions</u>
The following is a list of switch functions found on the control panel of the Fultz7 pump:

- ON Supplies power from selected power source to pump motor.
- OFF Turns pump off.
- INTERNAL Selects the internal battery array as the power source for the pump. Note: Because the external sources are more reliable and provide longer service, the internal batteries have been removed from all pumps.
- EXTERNAL Selects an external power source. Source must be plugged into the front panel at exterior source plug.
- FORWARD Selects forward operating mode, used to pump water from the source.
- REVERSE Selects reverse operating mode, used to empty water from hose through pump head and to flush silt from pump screen, when clogged.

CAUTION: Always turn the power off before changing direction of pump to prevent damage to unit or fuse failure.

Purging Procedures

The following steps detail the operation of the Fultz pump when used for purging monitoring wells. This pump is not used for sampling.

1. Select external power source to be used. If a generator is used, plug in to external source jack and place generator as far from the well as possible in the downwind direction. If 12-volt batteries are used, connect batteries with provided cables to provide 24 volts. Bridge the positive post of one battery to the negative post of the other. Next, place the red clip from the main supply cable (the long cable which plugs into the face of the control panel of the pump) on the remaining positive post and place the black clip on the remaining negative post.
2. Check pump head to make sure pump and electrical connections are secure.
3. Lower pump into well, placing pump head no more than one or two feet below the top of the water column.
4. Turn pump on and make sure REVERSE/FORWARD switch is in FORWARD position. If the polarity of the power connection is reversed, the amp meter will deflect to the left and the pump will be running opposite of the selected direction. Make the appropriate change.
5. During normal operating conditions, the pump should pull no more than 1.5 to 2.0 amps. Newly replaced rotors may temporarily pull slightly more amps. Check amp meter on control panel to make sure that the pump is operating in this normal range.
6. Listen to the pump, as this is an indication of the amount of water over the pump. As the water level is pulled down, the pitch of the sound will increase and become louder. If the water level is pulled down, lower the pump another one or two feet and continue to listen to the sound of the pump.
7. If the water level is rapidly lowered, caution must be observed as the pump is lowered in the vicinity of the bottom of the well. In this region, be sure to observe the clarity of the water and the amps being registered on the amp meter. If the water becomes extremely turbid and the amps increase beyond the acceptable range, these are indications that the pump has been lowered into silt at the bottom of the well. If this occurs, the pump should be momentarily reversed to dislodge the silt from the screen and rotors. If more volume is required to fully evacuate the well under these conditions, a bailer may be a more appropriate choice for the remainder of the purge.
8. After completing the required purge, remove the pump from the well and reverse the motor to empty the pump and hose of all contained water. The pump should be switched off as soon as the last water is discharged, since running the pump dry may damage the rotors. This water should be collected with the other purge water and handled appropriately. The pump and wetted portion of the hose may now be decontaminated prior to use at the next sampling location.

2.3 Tips and Precautions:

The following tips and precautions should be observed for best performance and operating conditions.

1. Watch the hose for kinks as the pump is lowered into the well, particularly checking what remains on the hose frame. Kinks will decrease pump performance and will generally manifest themselves as decreased output with higher amp meter readings. Badly kinked hose should be "red-tagged" for replacement.
2. Before going to the field, the pump's performance should be checked. At zero head, a properly operating Fultz7 pump should pump 1.1 to 1.2 gallons per minute. If much less than 1.1 gallons per minute is pumped, the rotors should be replaced and the pump re-checked. Worn rotors do not merely decrease the pump rate, they also reduce the operating head of the pump.
3. Make sure spare fuses are available. The 1.75-inch diameter pump heads require 2.5 amp fuses. The 2.5-inch diameter pump heads require 5 amp fuses.

2.4 Rotor Replacement:

Remove the five screws that hold the pump head on. Carefully rotate the pump cover at the wire, exposing the rotors. With needle-nose pliers, grip each rotor by a tooth and pull it out. Replace with new rotors by pushing them into place with your thumb. Be careful not to shave off the sides of the teeth on the pump body. Replace the pump cover and five screws. Gently snug the screws into place and back them off one turn. Place the pump in a bucket of water and, while running, gradually tighten the screws. This will wear off any burrs on the rotors and give the best performance.

2.5 Trouble Shooting:

No Power to Pump	1. Loose connection to power supply.	1. Make sure clips on battery are snug.
	2. Water leakage into motor.	2. Return to factory.
Pump Output Reduced	1. Hose kinked	1. Straighten hose.
	2. Rotors worn	2. Replace rotors.
	3. Intake clogged	3. Reverse pump direction to clear.
	4. Power supply low	4. Replace batteries.
	5. Silt or sediment in water.	5. If too bad, discontinue pump use.
High Amp Meter Reading	1. Pump out of water.	1. Lower pump into water column.
	2. Silt or sediment in water.	2. Watch amp reading. If it exceeds the recommended operating range, reverse direction of pump to clear intake. If this does not work, discontinue pumping and use bailer.

Large Diameter Electric Submersible Pumps

3.1 Introduction:

Pumps included within this category are any of the typical, large diameter (3-inch to 4-inch) electric submersibles. These pumps are necessary when large amounts of water must be removed from wells such as deep, 4-inch monitoring wells and drilled or bored potable wells.

These pumps are generally powered by 120-volt generators and require a minimum of two persons for operation. As such, utmost care should be observed to ensure the safe operation of this equipment, particularly from an electrical hazard standpoint. The following sections detail the safety and operation of these pumps.

3.2 Safety:

1. Place the generator on dry ground or plastic sheeting as far as practical from the well, in the down-wind direction, and ground it. Several grounding kits consisting of a roll of copper wire and a grounding rod are available. Wet the ground thoroughly with tap water at the grounding location, if dry, and drive the grounding rod several feet into the ground.
2. Inspect the electrical cord for frays, breaks, exposed wiring, etc.
3. Check the headspace of the well for the presence of an explosive atmosphere with a combustible gas meter.

4. A minimum of two people are required to place, retrieve, and operate these pumps safely. If they are used without the aid of the tripod, i.e., all electrical and suspension lines are spooled separately, at least three people are needed to successfully lower and raise the pumps.
5. Wear rubber safety boots to insulate against shock hazards.
6. If purge water is not collected, direct the discharge away from the well and generator, preferably downgradient of area.
7. Make sure that the generator is set to proper voltage.
8. Do not add gasoline or oil to the generator while it is running.
9. Carry the generator, gasoline, and oil in a trailer dedicated to this type of equipment. Do not haul this equipment in the back of any passenger vehicle or with any sampling equipment or containers.

3.3 Pre-loadout Checkout Procedure:
1. Check the oil and gasoline in generator, filling up as needed. Take generator outside and start it. Place a load on the generator, if possible.
2. Inspect the pump, and all hose, rope and electrical cord and connections.

3.4 Operation:
1. Connect pump to steel winch cable. Using winch crank, lower pump, hose and electrical cord into the well. If no tripod is available, lower the pump into the well by hand. This will require at least three people, one to lower pump with the rope, one to feed the hose and cord into the well, maintaining proper tension, and one to feed rope, hose and electrical cord from cart.
NOTE: Keep all hose, electrical cord and cable off of the ground at all times. Do not allow the rope, cord, or the hose to scrape or rub on the well casing.
2. Place pump five feet below the top of the water column.
3. Start generator, then connect power cord from pump.
4. After starting pump, closely observe operation to determine if drawdown is occurring in well. If the water level is not pulled down significantly, keep pump at initial level and continue to purge. If the water level drops, lower the pump to keep up with the drawdown. Do not allow the pump to run dry, as this will damage it.

3.5 Maintenance and Precautions:
1. Do not put away wet.
2. Empty hose of contaminated water before leaving sampling location. Do not bring back hose with water in it.
3. Do not pump dry.
4. Do not run generator without checking oil.

3.6 Trouble Shooting:

No Power to Pump	1. Loose connections at pump.	1. Check wiring at pump. Repair as needed. (Generator Off!!)
	2. Cord unplugged at generator.	2. Plug pump back in.
Generator Running, No Pump Output	1. Pump out of water.	1. Lower pump into water.
	2. Hose collapsed or kinked.	2. Unkink hose.
	3. Generator output failing.	3. Put load on generator and check output or check voltage output meter.

Sluggish Discharge	1. Sediment or other material clogging screen.	1. Remove material from screen.
	2. Kinked hose.	2. Unkink hose.

Appendix J: UST Management Division Retention Schedule

COPY

DEPARTMENT OF HEALTH
AND ENVIRONMENTAL CONTROL

Record Group Number: 169

ENVIRONMENTAL QUALITY CONTROL

BUREAU OF LAND AND WASTE MANAGEMENT

UNDERGROUND STORAGE TANK

13300 REHABILITATION INFORMATION

Description

Used to document the clean up process for releases that have occurred at sites with regulated underground storage tanks. Information includes assessment, monitoring reports, corrective action plans, reports, no further action letters or case closure letters, and correspondence.

Retention

All official records: 9 years after no further action letter or a case closure letter is issued, destroy.

(REVISED)

Approval Date: 27 March 2008

Appendix K: Contractor Verification Checklist

Contractor Checklist

For each report submitted to the UST Management Division, the contractor will be required to verify that all data elements for the required scope of work have been provided. For items not required for the scope of work, the N/A box should be checked. For items required and not completed or provided, the No box should be checked and a thorough description of the reason must be provided.

Item #	Item	Yes	No	N/A
1	Is Facility Name, Permit #, and address provided?			
2	Is UST Owner/Operator name, address, & phone number provided?			
3	Is name, address, & phone number of current property owner provided?			
4	Is the DHEC Certified UST Site Rehabilitation Contractor's Name, Address, telephone number, and certification number provided?			
5	Is the name, address, telephone number, and certification number of the well driller that installed borings/monitoring wells provided?			
6	Is the name, address, telephone number, and certification number of the certified laboratory(ies) performing analytical analyses provided?			
7	Has the facility history been summarized?			
8	Has the regional geology and hydrogeology been described?			
9	Are the receptor survey results provided as required?			
10	Has current use of the site and adjacent land been described?			
11	Has the site-specific geology and hydrogeology been described?			
12	Has the primary soil type been described?			
13	Have field screening results been described?			
14	Has a description of the soil sample collection and preservation been detailed?			
15	Has the field screening methodology and procedure been detailed?			
16	Has the monitoring well installation and development dates been provided?			
17	Has the method of well development been detailed?			
18	Has justification been provided for the locations of the monitoring wells?			
19	Have the monitoring wells been labeled in accordance with the UST QAPP guidelines?			
20	Has the groundwater sampling methodology been detailed?			
21	Have the groundwater sampling dates and groundwater measurements been provided?			
22	Has the purging methodology been detailed?			
23	Has the volume of water purged from each well been provided along with measurements to verify that purging is complete?			
24	If free-product is present, has the thickness been provided?			
25	Does the report include a brief discussion of the assessment done and the results?			
26	Does the report include a brief discussion of the aquifer evaluation and results?			
27	Does the report include a brief discussion of the fate & transport models used?			

Item #	Item	Yes	No	N/A
28	Are the site-conceptual model tables included? (Tier 1 Risk Evaluation)			
29	Have the exposure pathways been analyzed? (Tier 2 Risk Evaluation)			
30	Have the SSTLs for each compound and pathway been calculated? (Tier 2 Risk Evaluation)			
31	Have recommendations for further action been provided and explained?			
32	Has the soil analytical data for the site been provided in tabular format? (Table 1)			
33	Has the potentiometric data for the site been provided in tabular format? (Table 2)			
34	Has the current and historical laboratory data been provided in tabular format?			
35	Have the aquifer characteristics been provided and summarized on the appropriate form?			
36	Have the Site conceptual model tables been included? (Tier 1 Risk Evaluation)			
37	Has the topographic map been provided with all required elements? (Figure 1)			
38	Has the site base map been provided with all required elements? (Figure 2)			
39	Have the CoC site maps been provided? (Figure 3 & Figure 4)			
40	Has the site potentiometric map been provided? (Figure 5)			
41	Have the geologic cross-sections been provided? (Figure 6)			
42	Have maps showing the predicted migration of the CoCs through time been provided? (Tier 2 Risk Evaluation)			
43	Has the site survey been provided and include all necessary elements? (Appendix A)			
44	Have the sampling logs, chain of custody forms, and the analytical data package been included with all required elements? (Appendix B)			
45	Is the laboratory performing the analyses properly certified?			
46	Has the tax map been included with all necessary elements? (Appendix C)			
47	Have the soil boring/field screening logs been provided? (Appendix D)			
48	Have the well completion logs and SCDHEC Form 1903 been provided? (Appendix E)			
49	Have the aquifer evaluation forms, data, graphs, equations, etc. been provided? (Appendix F)			
50	Have the disposal manifests been provided? (Appendix G)			
51	Has a copy of the local zoning regulations been provided? (Appendix H)			
52	Has all fate and transport modeling been provided? (Appendix I)			
53	Have copies of all access agreements obtained by the contractor been provided? (Appendix J)			
54	Has a copy of this form been attached to the final report and are explanations for any missing or incomplete data been provided?			

Explanation for missing and incomplete information?

Appendix L: SCDHEC EQC and OCRM Quality Management Plan

From the SC DHEC Quality Management Plan

9.0 COMPUTER HARDWARE AND SOFTWARE

The Department is committed to following Federal/State mandates regarding protection of data, and software/hardware requirements.

The Department's Chief Information Officer (CIO) manages the process of identifying Management Information Technology (IT) needs and developing a cost-effective Management Information System to satisfy those needs. A core group of technical representatives known as IRCJV – Information Resource Consultant Joint Venture Committee, assists the CIO in this effort. Members are from each Deputy area within the Department. The CIO and the IRCJV Committee are responsible for providing standard operating procedures and for identifying and prioritizing IT needs. Together they also evaluate proposed changes that may have the potential for cross-program impact.

The CIO and the Core Group or the appropriate Deputy Managers will identify and prioritize the Department's needs. The Department's Bureau of Business Management is involved in all aspects of procurement dealing with any and all IT projects. Depending on the cost of the project, the State's CIO office within the Budget and Control Board may be involved in the process as well. This process is completed via a work plan that specifies the requirements, responsibilities, and the schedule(s) of deliverables.

All hardware and software solutions are evaluated prior to purchase using industry best practices, experience from other states and demonstrated performance. The Department adheres to all mandatory State procurement guidance to ensure the best price via appropriate market competition for the selected product or service.

A Data Quality Team has been established to ensure the effectiveness and quality assurance of the information produced from or collected by our Environmental Facilities Information System (EFIS) is uniform. The group's long-term goal is to maximize the use of the Department's Enterprise Wide Information Management System. EQC also works closely with EPA to ensure complete and accurate data is submitted through the Exchange Network Node System. The workgroup is currently improving cross program access to data, improving data extraction results and implementing improved public access to Departmental information.

In each Bureau, IT (Information Technology) Staff are assigned to be responsible for maintaining the integrity of the computer databases and information systems within that Bureau. They ensure that the records are backed up routinely and that transfers from one area to another of electronic records are done accurately. This Section also ensures that virus protection is kept up to date on each computer in the Bureau.

Prior to data being input to computer databases, it is checked by the analyst and their supervisor. This review includes a check on the calculations and raw data. A percentage of data is checked by a third data verifier. Once the data is transferred to the Program Areas (the Bureau of Water-for example), that Program area is responsible for the data integrity.

The EQC Monitoring Workgroup is currently leading the effort to enable the Department to receive electronic data deliverables (EDDs) from external laboratories as well as developing a method of producing EDDs from the EQC Laboratories LIMs (Laboratory Information Management System). Our goal is to be able to generate a SEDD Level 2A deliverable within two years. We will begin this effort by implementation on a small project. The Data Quality Team and the EPA will be consulted during this process. The goal of this (ADR) is to further certify that the data quality is sufficient to make sound environmental decisions.

Appendix M: Project Status Update Form

UST Permit # (Facility Name)

Date	Current Status	Deficiency	Corrective Action Taken	Date Deficiency resolved

Comments:____

Appendix B

Laboratory Standard Operating Procedures

GULF COAST ANALYTICAL LABORATORIES, INC

QUALITY ASSURANCE PROGRAM PLAN

FOR

GCAL Inc.
7979 GSRI Avenue
Baton Rouge, Louisiana 70820
225-769-4900

Revision 30
September 29, 2011

Approval Signatures:

Karen S. Varnado
Thu Sep 29 2011 14:04:58
9/29/2011

Randy Whittington – Chief Executive Officer Date

Karen S. Varnado
Thu Sep 29 2011 14:03:01
9/29/2011

Scott Bailey – Laboratory Director Date

Thu Sep 29 2011 10:57:03
9/29/2011

Allison Naquin – Technical Services Director Date

Karen S. Varnado
Thu Sep 29 2011 10:01:45
9/29/2011

KarenVarnado – Quality Assurance Manager Date

1 QUALITY ASSURANCE POLICY STATEMENT

Quality Assurance consists of a planned system of activities necessary to provide confidence in the results of laboratory analytical determinations. The principal objective of Gulf Coast Analytical Laboratories, Inc. (GCAL) is the production of high quality analytical data through the use of measurements that are accurate and reliable for the intended purpose. We are dedicated to providing analytical data and services that conform to all of the requirements specified and expected by our clients. This Quality Assurance Program Plan (QAPP) details facilities, personnel and equipment necessary for accomplishing this objective along with general procedures and practices that will be followed to maintain adherence to the objective. All policies and procedures have been structured in accordance with The NELAC Institute (TNI) Standards, the Department of Defense (DOD) Environmental Laboratory Accreditation Program requirements, and in accordance with applicable state and federal regulations, approved reference methods, and guidance documents. GCAL's management staff is dedicated to maintaining compliance with state and federal regulations, TNI Standards and the DOD requirements.

There is a commitment and dedication by all laboratory staff to produce data of known and documented quality. This commitment and dedication to quality is fully supported from the bench level to upper management in order to meet the objectives of our laboratory and best serve our clients.

GCAL's approach to Quality Assurance starts with the Chief Executive Officer (CEO) who delineates policy and sets goals in conjunction with senior management personnel. Management staff and laboratory personnel implement policies. All departments are involved in the process by providing assessment of operating procedures along with recommendations for improvements or corrections. The QAPP and the appropriate Standard Operating Procedures are distributed to all laboratory personnel as controlled documents according to SOP QA-001 (Document Control). All personnel are required to read and comply with this program.

The Quality Assurance Manager (QA Manager, QAM) oversees prevention, assessment, and correction procedures for the analytical laboratory and various associated departments within the organization. These three functions; prevention, assessment, and correction, comprise the foundation of the laboratory's approach to Quality. Through this foundation, GCAL's management staff is committed to continually improve the quality system.

Prevention covers positive actions taken before or during analyses to insure that the analytical systems are functioning properly. Prevention includes such things as instrument calibration and maintenance, frequent standardization, personnel training and quality control planning.

Assessment is a component of quality control that includes monitoring of performance to determine precision and accuracy. Examples include duplicate and spike analyses, check samples, peer review of calculations and validation of methodology.

Correction is action taken to determine the causes of quality non-conformances and to restore proper functioning of the analytical system. This includes trouble shooting to correct instrument malfunctions, or retraining of personnel.

All quality assurance activity requires constant monitoring and documentation to provide evidence of consistent, valid analytical data. GCAL keeps records of such activities in order to have available for its clients documented assurance that the data they receive quantitatively reflect the parameters requested.

The policies and practices of quality assurance/quality control presented in this plan are set forth as minimums. Additional quality assurance/quality control measures are defined by a specific project plan.

In the case of discrepancies between this document and SOPs, the SOP shall take precedence. A list of supporting SOPs including technical procedures is located in Appendix F of this document.

____

Randy Whittington, CEO

2 ETHICS POLICY

GCAL utilizes a clearly stated ethics policy in the form of the following Ethics and Data Integrity Statement. This agreement is discussed with all new employees during orientation and is then signed and retained with the employee's training file. Violation of the agreement is basis for termination of employment. Employees receive training in data integrity and their ethical responsibilities annually. Each employee must sign GCAL's Ethics and Data Agreement annually. The signed document will be kept in the employee training records.

GCAL's management takes seriously any allegations of improper, unethical or illegal activities. All allegations shall be investigated, fully documented and treated as confidential. The identity of the employee reporting the possible ethics violation shall be maintained as confidential. GCAL's management shall not retaliate against any employee raising ethical questions.

GULF COAST ANALYTICAL LABORATORIES, INC.

ETHICS AND DATA INTEGRITY AGREEMENT

I, ________________________, state that I understand the high standards of integrity required of me with regard to the duties I perform and the data I report in connection with my employment at GCAL. Our core values are honesty, success, service and integrity. I understand that it is critical for our long-term success that each and every employee aligns with all company core values.

I agree that in the performance of my duties for GCAL and its clients, I shall conform to the following ethics standards and will report immediately to the Quality Assurance Manager and the appropriate supervisor any information concerning misrepresentation of analytical data that includes, but is not limited to:

1) Altering an instrument computer or clock for any inappropriate purpose;

2) Altering the contents of logbooks and/or data sheets to misrepresent data;

3) Misrepresenting an analyst's identity;

4) Changing raw data documents with correction fluid or obliteration;

5) Preparation and submittal of fraudulent data packages;

6) Inappropriate calibration techniques such as peak shaving, setting fraudulent integrator parameters, or use of computer macros that alter QC results.

7) Changing reported results without proper documentation and approval;

8) Altering injection volumes for calibration and misrepresenting the true values;

9) Failure to comply with standard operating procedures or methods without proper documentation and approval;

10) Any attempt to misrepresent data or events as they actually occur in the course of data production, review or reporting;

11) Disposing of or deleting electronic data files or hardcopies of raw data;

12) Failure to analyze all QC and PT samples in the same manner as client samples. This includes glassware selection, all prep steps, any clean up steps, reagent addition, and analysis, unless specified to be different by the SOP or reference method;

13) Engaging in any practice that ultimately misrepresents data or narratives in any way.

I will not knowingly participate in any such activity and will not tolerate unethical practices by others. I understand that confidentiality will be strictly enforced by GCAL when dealing with these matters. As a further extension of my commitment to this program, I am responsible for seeking approval to report data resulting from techniques or procedures that deviate from standard operating procedures, methods, or industry standard practices. Any such reporting of data will include a laboratory narrative that must be approved by the appropriate supervisor and the QAManager.

If I am unsure of how to properly handle data generated by me, I am responsible for seeking advice and approval from the Quality Assurance Manager and the appropriate supervisor. I agree to inform the Q A Manager and the appropriate supervisor of any accidental reporting of non-authentic data by others or myself within 24 hours of discovery.

I understand that if I knowingly participate in any prohibited activity, I will be subject to disciplinary action that may include immediate termination by GCAL. I also understand that I face individual suspension and debarment from all Federal programs should I be convicted of such practices. I understand that suspension and debarment from all Federal programs affects my ability to work in the environmental field, as well as, any other profession where government funding or loans may be involved. I understand the most serious consequence of unethical conduct can be imprisonment if convicted.

I understand that it is not the company’s intent to punish anyone for an accidental mistake or oversight. Employees will not face disciplinary actions for an accidental mistake or oversight. Repeated careless or neglectful behavior will be subject to corrective action. Covering up an accidental mistake or oversight is not acceptable behavior and will result in termination. Mistakes or oversights are immediately reported to the appropriate supervisor and/or QAM.

My signature affirms my understanding of the consequences of violating GCAL's ETHICS AND DATA INTEGRITY AGREEMENT and my commitment to its intent. My signature further affirms that I have received formal training on this topic.

Printed Name

Signature Date

3 Administrative Organization

GCAL is organized along clear lines of authority to provide our clients with service that is efficient and reliable. The organizational structure of the laboratory is shown in Appendix A.

It is the policy of the laboratory that each management and operational level has a designated deputy or deputies to maintain continuity of service and other functions whenever key staff is absent. The deputies are responsible for the completion of duties during the staff member's absence. For the purposes of certification, the Technical Services Director has the responsibilities of the Technical Director as defined by TNI. In the event that the Technical Services Director is not able to perform his/her duties for more than 35 consecutive calendar days, GCAL will notify the accrediting authorities in writing and will identify the temporary Technical Services Director. Temporary deputies are defined in the chart below.

Position	**Deputy**
Chief Executive Officer (CEO)	Technical Services Director
Laboratory Director	Technical Services Director
Technical Services Director	Laboratory Director or Quality Assurance Manager
Quality Assurance Manager	Technical Services Director
Department Manager	Department Supervisor
Department Supervisor	Group Leader
IT Manager	Laboratory Director and/or CEO

3.1 Roles, Responsibilities, and Qualifications

The following lists the general roles and responsibilities in each level of the laboratory. Resumes of key personnel are attached in Appendix B. Management ensures that each employee is independent from commercial, financial, or other pressures that might adversely affect the quality of test and reporting of results.

All employees are responsible for complying with GCAL's quality system. It is the responsibility of every employee to perform the duties outlined in this Quality Assurance Manual or as assigned by management.

The CEO, Technical Services Director, Laboratory Director, Quality Assurance Manager, Department Managers or any Supervisor may halt work and withhold reports when non-conforming work is identified. In addition, management may halt work if an employee is observed not following laboratory procedures or if the employee is observed performing questionable acts while analyzing samples. Work will not be resumed until such time as the CEO, Technical Services Director, Laboratory Director and/or Quality Assurance Manager has deemed the process to be compliant with GCAL's policies and procedures.

3.1.1 The Chief Executive Officer (CEO) bears the primary responsibility for data quality at GCAL and directs laboratory policies. The CEO:

- is responsible for the laboratory and its employees.
- directs the functional areas of marketing and finance.
- makes financial decisions for the laboratory.
- sets goals and objectives for the laboratory.
- supervises the Chief Financial Officer, IT Director, Technical Services Director, Laboratory Director and the Safety/Regulatory Compliance Officer.
- as a member of management participates in strategic planning to develop short-term and long-term goals for the laboratory.

3.1.2 The Laboratory Director (Lab Directory) is responsibility for data quality at the laboratory. The Lab Director must have a degree in chemical, environmental, biological sciences, physical science or engineering with at least 24 college credit hours in chemistry and at least 5 years of experience in environmental testing. The Lab Director is responsible for the supervision of laboratory operations and reporting results. The Lab Director:

- reports to the CEO.
- reviews, approves and implements the Quality Assurance Project Plan, all policies and standard operating procedures in the laboratory.
- sets goals and objectives for the laboratory and employees.
- makes personnel and financial decisions.
- assures the laboratory has sufficient resources for the timely generation of data.
- provides day-to-day supervision, conducts performance appraisals, and delegates work assignments to personnel.
- monitors standards of performance in quality control and quality assurance.
- monitors the validity of the analyses performed and data generated in the laboratory to assure data are of known and documented quality.
- directs the development, validation, and implementation of new test methods as necessary.
- is responsible for maintaining the work environment, which encourages open, constructive problem solving and continuous improvement.
- as a member of management participates in strategic planning to develop short-term and long-term goals for the laboratory.

3.1.3 The Technical Services Director is responsible for coordinating the activities of the Quality Assurance Department, the Sample Administration Department, Client Services Department, and administrative support personnel. The Technical Service Director must have a degree in chemical, environmental, biological sciences, physical science or engineering with at least 24 college credit hours in chemistry and at least 5 years of experience in environmental testing. The Technical Services Director:

- reports to the CEO.
- reviews and approves the Quality Assurance Project Plan and applicable standard operating procedures for the laboratory.
- defines, communicates and enforces quality standards.
- provides day-to-day supervision, conducts performance appraisals, and delegates work assignments to personnel.
- is responsible for ensuring that all quality related requirements are understood and implemented by the laboratory.
- is responsible for effectively communicating with clients all quality related requirements.
- tracks and identifies new opportunities to improve GCAL’s methods and employee training.
- reviews and approves all technical proposals.
- as a member of management participates in strategic planning to develop short-term and long-term goals for the technical services department and the laboratory.

3.1.4 The Information Technology Director manages the implementation and development of information technology tools. The IT Director is responsible for the automated data collection systems used by the laboratory. The IT Director:

- reports to the CEO.
- works with management and employees to assess and respond to GCAL’s IT needs.
- provides day-to-day supervision, conducts performance appraisals, and delegates work assignments to IT personnel.
- is responsible for maintaining the integrity and continual operations of GCAL’s network and LIMS.
- is responsible for developing and ensuring that all system backups are performed as scheduled.
- is responsible for developing, reviewing and certifying all back-up and disaster recovery procedures.
- maintains security and privacy of LIMS and computer systems.
- oversees the development, design and implementation of new applications and changes to the existing computer systems and software packages.

- interacts with clients to determine IT requirements such as electronic data deliverables.
- as a member of management participates in strategic planning to develop short-term and long-term goals for the IT department and the laboratory.

3.1.5 IT Assistant:

- reports to the IT Director
- assist in maintaining the LIMS system.
- assist in performing system backups.
- assist in maintaining the integrity and continual operations of GCAL's network and LIMS.
- performs other duties as assigned by the IT Director.
- performs other duties as assigned.

3.1.6 The Report Validation Manager:

- reports to the Laboratory Director.
- provides day-to-day supervision, conducts performance appraisals, and delegates work assignments to personnel.
- is responsible for report validation and review.
- is responsible for review of Quality Assurance Project Plans for incoming projects and notifies the laboratory of project specific requirements.
- assists the lab in method development and implementation.
- is responsible for reviewing final reports. Any discrepancies found in the data are reported to the appropriate Department Supervisor for review and correction if necessary.
- is responsible for signing final reports.
- supervises the receptionist, report validation, data production, and report generation groups.
- Performs other duties as assigned.

3.1.7 The Quality Assurance Manager is responsible for implementing, maintaining and improving the quality system throughout the laboratory. The Quality Department operates independent of the production pressures of the laboratory. The QA Manager must have a degree in chemical, environmental, biological sciences, physical science or engineering with at least 24 college credit hours in chemistry and at least 2 years of experience in environmental testing. If the QA Manager is absent then the Technical Services Director is the deputy. The QA Manager:

- reports to the Technical Services Director.
- supervises the Quality Assurance Technician.
- operates independently from the laboratory operations.
- is responsible for maintaining the laboratory's certification status.
- serves as the focal point for the quality system and is responsible for oversight and/or review of quality system.
- is responsible for the preparation and maintenance of the GCAL's Quality Assurance Program Plan.
- acts as the liaison between the laboratory and external parties on matters relating to GCAL's quality system and/or external assessments and audits.
- is the contact for performance testing studies and project-specific quality control issues.
- coordinates the analysis of proficiency test samples and maintains records of the results.
- monitors analysts' training records and verifies that training records are adequate and current.
- approves and confirms the implementation of corrective actions.
- is responsible for the approval and distribution of controlled documents.
- has the authority to intercede in all areas where quality related problems exist. No work will be released until the related quality deficiency has been corrected and approval has been given to proceed forward.
- must have training in QA/QC and a general knowledge of the tests included in GCAL's scope of accreditation.
- is responsible for implementing, maintaining, and improving the quality system;
- ensures that all personnel understand their contributions to the quality system.
- ensures communication takes place at all levels within the laboratory regarding the effectiveness of the quality system.
- evaluates the effectiveness of training.
- Conducts internal audits annually and provides documentation of these audits to management.
- meets with laboratory staff to disclose issues of non-compliance identified during internal audits to develop corrective action strategies.
- uses internal audits, third party assessments, control charts, proficiency testing results, data analysis, corrective and preventive actions, customer feedback, and management reviews in an efforts to monitor trends and continually improve the quality system.
- performs other duties as assigned.

3.1.8 Quality Assurance Technician:

- reports to the Quality Assurance Manager.

- tracks and assists in developing laboratory logbooks including assembling, retrieving and archiving.
- tracks and verifies internal calibration programs.
- assist with revising SOPs as assigned and enters the SOPs into GCAL's intranet.
- obtains purchase orders for and schedules calibration services.
- assist with employee training and assists in maintaining the employee training records.
- assist in preparing for and assist during internal audits, external audits and assessments.
- assist with GCAL's proficiency testing program.
- assist the Quality Assurance Manager in implementing the quality system and in ensuring that the quality system is followed at all times.
- assist in obtaining and updating documents for training and/or experience in QA/QC procedures and is knowledgeable in the quality system as defined by State Regulations and TNI standards.
- completes applications for renewal of accreditation.
- performs other duties as assigned.

3.1.9 Department Managers:

- report to the Laboratory Director.
- are responsible for the overall flow of work and data through their department.
- provide day-to-day supervision, conduct performance appraisals, and delegate work assignments to personnel in the laboratory.
- are responsible for the maintenance of accurate SOP's with input from the QA/QC Department.
- are responsible for training laboratory personnel.
- are responsible for reviewing and validating data released from the department.
- supervise the quality control activities performed as part of routine analytical operations
- perform other duties as assigned.

3.1.10 Department Supervisors:

- report to the Department Manager.
- are responsible for the overall flow of work and data through their section/area.
- provide day-to-day supervision, conduct performance appraisals, and delegate work assignments to personnel in the laboratory.
- are responsible for the maintenance of accurate SOP's with input from the QA/QC Department.

- are responsible for all activities within their section/area, ensuring that all instrumentation and equipment meet performance criteria and calibration requirements.
- are responsible for training laboratory personnel.
- are responsible for validating data released from their section/area of the laboratory.
- inform the Department Manager or Laboratory Director of project status and any laboratory capacity issues.
- must have experience in the methods performed in their section/area and experience in data review and validation.
- perform other duties as assigned.

3.1.11 Lab Analysts/chemists:

- report to the Department Supervisor.
- are responsible for the generation of data by analyzing samples in accordance with GCAL's approved and implemented standard operating procedures in a manner that meets regulatory and reference method requirements.
- are responsible for recording all observations during analysis and for ensuring that all documentation related to the analysis is accurate and complete.
- are required to notify the Department Supervisor, Department Manager, Lab Director or Quality Assurance Manager of any quality issues immediately upon discovery.
- have the authority to accept or reject data based on compliance with QC acceptance criteria.
- are responsible for the initial data review.
- are required to be familiar with reference methods cited in GCAL approved SOPs.
- are required to read the Quality Assurance Program Plan.
- are required to be familiar with state and federal regulation that apply to analytical testing procedures.
- perform other duties as assigned.

3.1.12 Project Managers/Client Services:

- report to the Laboratory Technical Director.
- are responsible for scheduling client projects.
- communicate to laboratory personnel any project-specific requirements.
- review log-in summaries.
- notify the client of sample receipt and/or analytical problems.
- monitor the progress of analytical work and provides data to the client in a timely manner.

- documents client inquiries.
- perform other duties as assigned.

3.1.13 Group Leaders:

- report to the Department Supervisor.
- are the temporary deputies in the event the Department Supervisor is absent.
- guide the scheduling of sample analysis.
- ensure there is sufficient staff available.
- perform other duties as directed by the Department Supervisor or member of management.

3.1.14 Safety/Compliance Officer

- reports to the CEO
- provides safety training for GCAL's employees.
- is responsible for checking and maintaining safety equipment.
- has knowledge of waste disposal regulations.
- Coordinates waste disposal activities including documenting waste disposal.
- performs safety audits and reports findings to management.
- performs other duties as assigned.

3.1.15 Couriers

- Report to the Technical Services Director.
- Responsible for pickup and delivery of client samples to the laboratory.
- Responsible for sample collection on an as needed basis.
- Perform other duties as assigned.

3.2 Personnel Training

It is the policy of GCAL to hire employees with an educational background and/or experience in an analytical field. On-the-job training takes place for all new employees based on needs identified by the job description and tasks required by the position. New employees are hired for a probationary period of three months. At the end of three months the employee's records are reviewed and evaluated for performance and productivity and a decision is made whether to continue employment.

It is the responsibility of every employee to perform their job duties as outlined in this QAPP and in accordance with GCAL's SOPs. All quality system documents are communicated to the appropriated personnel. Documents that are included in the quality system are available to all employees on GCAL's Intranet site and/or hardcopy.

3.2.1 GCAL's training program begins with an orientation designed to familiarize the new employee with safety and chemical hygiene issues, the importance of QA/QC in an analytical laboratory, general laboratory procedures, and GCAL's policies. All employees undergo training in ethical and legal responsibilities including the potential penalties for improper, unethical, or illegal actions. Each employee must read and sign GCAL's Ethics and Data Integrity Agreement. Employees are required to read the laboratory QAPP at the time of hire and any time the QAPP is revised. All technical personnel undergo a training process involving lecture tapes that cover basic laboratory tasks. A written test follows each tape. Employees who perform or review manual integrations as part of their job duties receive training on GCAL's manual integration policy. Employees performing manual integrations must sign GCAL's Manual Integration Policy Statement.

3.2.2 New employees are under the direct supervision of experienced analysts and/or the department supervisors who are responsible for instructing the Trainee on the analytical procedures including the applicable QA/QC. Training includes reviewing Standard Operating Procedure (SOP) appropriate to the Trainee's job duties, appropriate reference methods, and hands-on training with instruments and/or equipment. Reference methods are available to laboratory personnel either in hardcopy or electronically. Copies of the EPA Test Methods for Evaluating Solid and Chemical Waste (SW846), Chemical Analysis for Water and Wastes, Standard Methods For The Examination of Water and Wastewater, and ASTM methods are available. The analyst in training must perform an acceptable initial demonstration of capability (IDOC) before being allowed to analyze samples without direct supervision. The IDOC consists of successfully analyzing four consecutive laboratory control samples (LCS) that have been prepared at a specified concentration using a certified stock standard. The 4 aliquots shall be analyzed either concurrently or over a period of days if necessary. The IDOC will be deemed acceptable if the precision and accuracy meet the requirements established by GCAL.

3.2.3 Analyst are required to complete a continuing demonstration of capabilities (DOC) whenever there is a significant change to the instrument or test method or at minimum annually unless otherwise required by the reference method. The DOC shall include one of the following: acceptable performance of a Proficiency Test sample; performance of 4 consecutive LCS samples that meet the laboratory's requirements for precision and accuracy. Refer to SOP QA-014 for addition information on demonstrations of capabilities.

3.2.4 GCAL recognizes developmental training as a means to increase the effectiveness of the employee and the organization. Therefore, GCAL utilizes other training methods along with on-the-job training. Examples include seminars, specialized training by instrument manufacturers, and internal training courses. GCAL encourages employees to take college courses appropriate to the work performed by the laboratory.

3.2.5 On-going proficiency is documented using the Demonstration of Certification Statement form and must be signed by the Analyst, Technical Services Director and the Quality Assurance Manager. The signed Certification Statement and supporting data are kept in the employee's training records.

3.2.6 Additional training will be required for an employee whose performance does not meet standard requirements.

3.2.7 Periodic performance reviews are given to all personnel. The purpose of these reviews is to give recognition for good work when desired, outline personnel and departmental objectives, suggestions for improvement and clarification of responsibilities.

3.3 Training Records

The QA/QC Department maintains training records for each employee. The records include the demonstration of capability, training course certificates, in-house or external training seminar documentation, and ethics agreement and manual integration agreements if required.

4 QUALITY ASSURANCE/QUALITY CONTROL

4.1 Quality Assurance Responsibilities

Quality Assurance (QA) is defined as an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets the defined standards of quality with a stated level of confidence. (NELAC 2003) QA is an integral part of GCAL's quality system. The direct and ultimate responsibility for assuring data quality at GCAL rests with the CEO. The CEO develops policies and general quality assurance strategies in collaboration with the management staff and department supervisors.

GCAL has clearly defined staff (QA) responsibilities. The first level of QA lies with the laboratory analyst, who is responsible for performing the work properly, documenting it, and obtaining peer review to assure that the data meets scientific standards. To accomplish this, the analyst must have a clear understanding of the analytical techniques and procedures used and the factors that affect the quality of the results. Analysts' capabilities are verified prior to conducting analyses and reviewed periodically thereafter.

Analysts must have a working knowledge of the QA policies, including data quality objectives for laboratory control standards, duplicates and spikes; an understanding of detection limits and standard calibration requirements; and knowledge of preventive maintenance techniques. All staff is required to review and follow all applicable SOPs and the Quality Assurance Program Plan.

The second level of quality assurance lies with the management staff and department supervisors. Management is responsible for the proper training of analysts and stressing the importance of accuracy and reliability of results. Management is responsible for the quality of all analytical data produced. This responsibility includes routine review and approval or disapproval of all data and inspection of the QC records associated with the data. If the data are not adequately substantiated, corrective action is taken.

The QA manager is responsible for the the QA/QC program. This includes administration of the program as outlined in this document, maintenance of QA records including this QAPP, and preparation of reports to management covering QA activities. The QA Manager or designee performs annual audits of QA procedures and employees, establishes and maintains accreditation, and coordinates all proficiency testing. The QA Manager oversees the corrective action program.

4.2 Proficiency Testing (PT studies)

GCAL participates in a minimum of two TNI and State approved proficiency test studies each year and performs corrective action PT studies as necessary. The QA/QC Department orders the required PT studies at approximately six-month intervals from a TNI and/or state approved Proficiency Test Provider. When PT samples are received, the QA Technician or designee will log the PT samples into the LIMS. The PT study is assigned a work order number. PT samples are handled as client samples throughout the analytical process. PT samples will be handled as real environmental samples utilizing the same analyst, procedure, and equipment as would be used for client samples. PT samples will not be analyzed in multiple replicates or dilutions unless specified by GCAL's analytical SOP. The QA/QC department and department supervisor will be notified immediately of any problems encountered with the PT sample.

The QA/QC Department is responsible for the reviewing and reporting PT results to the PT provider. PT results and associated batch QC are reviewed in the same manner as a client's sample result. The review includes sample prep for appropriate dilution, reported concentration, consistency across methods, logical results, and transcription errors. Batch QC failures will necessitate re-analysis of the PT sample, or comments in the case narrative. If GCAL must withdraw from a PT study, the primary accrediting authority and PT provider will be informed in writing prior to the close of the study. PT results are reported to the PT provider by electronic submission.

The QA Manager shall review scored results for performance and accuracy. Results scored "Not Acceptable" shall be thoroughly investigated to determine the cause of the failure, corrective action performed and a supplemental PT sample analyzed to re-establish successful performance. Documentation of scored PT results, raw data, and corrective action shall be kept on file. GCAL will notify LDEQ, ACLASS and all other accrediting authorities of any "Not Acceptable" PT results, the cause of the PT failure, corrective actions implemented, and the results of the supplemental PT used to re-establish successful performance.

It is inappropriate for any employee to share results or to attempt to obtain results from any other laboratory participating in the PT or from the PT provider. GCAL will not knowingly accept PT samples or portions of PT samples from other laboratories.

GCAL utilizes the first WP Study of the year allowed by EPA to meet DMRQA requirements for clients that use GCAL for analysis of samples regulated by a discharge permit. Samples are analyzed, reviewed, and the applicable results are reported to the client.

It is the responsibility of the QA Manager to maintain compliance with TNI Standards, Louisiana Administrative Code and DOD regulations regarding PT analysis and reporting. Compliance includes passing two of the three most recent studies and performing PT studies for every matrix/method/analyte offered by approved PT providers. The QA/QC department shall suspend any matrix/method/analyte combination that fails two of the three most recent PT studies until the laboratory meets the requirements of initial acceptability. Refer to SOP QA-015 for more details.

4.3 Accreditation

GCAL is accredited by The NELAC Institute (TNI), Certificate number 01955. The primary accrediting authority is the Louisiana Environmental Laboratory Accreditation Program (LELAP) administered through Louisiana Department of Environmental Quality. A full list of accreditations is maintained in the QA department and listed in Appendix E.

Compliance with and maintenance of laboratory accreditation is the responsibility of the QA Manager. Scopes of accreditation and certificates shall be kept on file in the QA department and scanned to the appropriate electronic file on the server. All correspondence with accrediting authorities will be kept on file in the QA Department.

Maintenance of accreditation is based on compliance with State regulations and the appropriate TNI Standard. When implemented the TNI Standards approved September 8, 2009 will be used for accreditation. It is the responsibility of the QA manager to be familiar with and implement the required changes when new regulations are promulgated or new standards approved.

4.4 Quality Control

Quality control is defined as the overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users. (NELAC 2003) This section describes the types of quality control samples used in the laboratory and how they are used to determine precision and accuracy. When the analysis of a sample set is completed, the results will be reviewed and evaluated to assess the validity of the data set. All QC samples are processed and analyzed using the same conditions as the samples.

4.4.1 A blank is a sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (NELAC 2003) A reagent and/or method blank is prepared and analyzed with each set of samples. Field blanks (if provided by the client) are analyzed to determine possible contamination during sample collection. Trip blanks are applicable to volatile organics analysis (VOA) where volatile contaminants may be introduced during shipment to the laboratory. Storage blanks are placed in refrigerators used for volatile sample storage at the laboratory and analyzed every two weeks.

The reagent and/or method blank results are evaluated for contamination. If high blank values are observed, laboratory glassware and reagents will be checked for contamination. Analysis will be halted until the source of contamination has been determined and corrective action taken. The concentration of an analyte in a reagent blank must be less than ½ the reporting limit or less than 5% of the analyte detected in the associated samples. Field blank results are evaluated similar to the reagent and/or method blanks. If high field blank values are encountered, the value will be narrated in the final report to the client. If the reagent and/or method blanks and the field blank exhibit significant contamination, the source of contamination may be within the laboratory. In the case of VOA's, ambient air in the laboratory and reagents shall be checked as possible sources of contamination. If method blanks are not acceptable, the associated samples must be re-prepped and analyzed. For storage blank criteria, refer to SOP GEN-010.

4.4.2 A Laboratory Control Sample (LCS) made from a matrix known to be free of the analytes of interest and spiked with a known and verified concentration of target compounds. The LCS is prepared and analyzed with each batch of twenty or fewer samples. The full list of target compounds or a representative list of target compounds for the method may be spiked into the LCS. If a representative list is used, the laboratory will insure that all target analytes are included in the spike mixture over a two year period. Some projects, such as DOD, require that all target analytes are spiked. Project specific information is documented by the project manager in the project profile in the LIMS. Analysts are responsible for reviewing project profiles for client requirements. Analyte free reagent water is used as the matrix for the LCS associated with water samples. A purified solid matrix such as Ottawa sand, Teflon beads, or sodium sulfate is used to prepare the LCS for soil or solid samples. For those tests where it is difficult to obtain a suitable solid matrix for spiking, analyte free reagent water is taken through the preparation and analysis procedure. A certified reference material may be used as an LCS. The analyte concentration range must be within the calibration range of the method. Because some analytes may interfere with an accurate assessment if spiked simultaneously, the spike chosen will represent the elution patterns of the target analytes. The results of check standards analyses are compared with the true values and the percent recovery of the check standard are calculated. An LCS that is determined to be within acceptance criteria establishes that the analytical system is in control and validates system performance for the associated batch of samples. If the LCS has been spiked with a large number of analytes it becomes likely that a few analytes will be outside the control limits. This may not indicated that the analytical system is out-of-control and corrective action may not be necessary. A marginal exceedance (ME) is defined as beyond the LCS criteria (3 standard deviations) and less than 4 standard deviations when allowed by the project. The number of MEs allowed is as follows:

- > 90 analytes in LCS, 5 analytes allowed in the ME of the LCS control limits.
- 71-90 analytes in LCS, 4 analytes allowed in the ME of the LCS control limits.

- 51-70 analytes in LCS, 3 analytes allowed in the ME of the LCS control limits.
- 31-50 analytes in LCS, 2 analytes allowed in the ME of the LCS control limits.
- 11-30 analytes in LCS, 1 analyte allowed in the ME of the LCS control limits.
- < 11 analytes in LCS, no analytes allowed in the ME of the LCS control limits.
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4.4.3 Marginal exceedances must be random. The same analyte repeatedly exceeding the LCS control limits indicates a systematic problem and requires investigation. The source of the error must be located and corrective action taken. If correction is required, the check standard is reanalyzed to demonstrate that the corrective action has been successful. Acceptable accuracy (control limits) is a requirement of the method or determined by the laboratory through the use of control charts.

4.4.4 A matrix spike is a sample to which known concentrations of target analytes have been added before sample manipulation is performed. Matrix spikes are included in each batch of twenty or fewer samples for those tests where spiking is applicable. The matrix spike is also referred to as the MS. The analytes to be spiked are specified in the reference method, SOP, client request or by regulation. Because some analytes may interfere with an accurate assessment if spiked simultaneously, the spike chosen will represent the elution patterns of the target analytes. The observed recovery of the spike versus the theoretical spike recovery is used to calculate accuracy as defined by percent recovery. If the accuracy value is outside the control limits for the given parameter, the LCS is reviewed to verify that the analytical system is in control. If the accuracy value is outside the control limit, the sample set (parent sample, MS/MSD, or duplicate) is reanalyzed for the parameter in question, unless insufficient sample volume is available or the samples are past holding time. Generally, matrix spike control limits are set as the LCS control limits. The same spike list and concentration as required for the LCS will be used for the MS.

4.4.5 A duplicate for each matrix type is included in each batch of twenty or fewer samples. Routinely, the laboratory includes a replicate sample (a sample the laboratory divides into two aliquots sometimes referred to as a duplicate sample) in inorganic test batches and a matrix spike duplicate (a duplicate of the matrix spike) in organic test batches. The type of duplicate to include in a batch is based on specific project requirements and method requirements. A Laboratory Control Sample Duplicate (LCSD) is included with each LCS per batch of samples. The MS/MSD pair is analyzed with each batch of samples if sufficient sample is available. Duplicate sample analysis for the sample set is used to determine the precision of the analytical method for the sample matrix. The duplicate results are used to calculate the precision as defined by the relative percent difference (RPD). If the RPD is above the control limit, the sample set shall be re-analyzed for the parameter in question or the failure is documented in the case narrative. In inorganic analysis, RPD's are not considered applicable if the concentration in the sample/duplicate is less than 5X's the reporting limit.

4.4.6 If required by the method, each sample is spiked with the method specified surrogate(s) prior to extraction and analysis. The results of the surrogate(s) are compared with the true values spiked into the sample. The percent recoveries of the surrogates are calculated and reported with the sample results. If recoveries are outside the control limits, corrective action is required or a comment in the case narrative is required. Surrogates are reported as diluted out, in an analysis requiring extraction, if a dilution greater or equal to 10X is performed on the sample. Surrogates are used to monitor instrument performance, extraction performance, and matrix affects in each sample analyzed. Required corrective actions for surrogate failures can be found in the analytical SOPs.

4.4.7 Internal standards are added if required by the method. Internal standards are used to correct for minor variations in retention times and/or response. In most cases internal standards are defined in the method. If not defined an internal standard that is similar in response but not present in the sample such as deuterated or less common isotopes shall be used. Internal standard performance is monitored as part of the method performance for response and, if applicable, retention time.

4.4.8 An initial calibration verification (ICV) is analyzed following the initial calibration and before any samples are analyzed. The ICV is a certified standard from a different manufacturer than the standard used for the initial calibration. If a second source standard is not available then GCAL will use a certified standard from the same vendor but with an independent lot number.

4.5 Statistical Control

As part of the analytical quality control program, the precision and accuracy for each analytical method is established by the use of control charts. The charts are used to assess the method performance over a period of time. A minimum of twenty points are used to establish a control chart. Control limits of ± three standard deviations are utilized. Marginal exceedences will be charted using ± four standard deviations if marginal failures are allowed by the project. Refer to Section 4.4.2 for additional information on MEs.

4.5.1 Control charts are used to predict trends (positive or negative) in the analytical processes and to determine when an analysis is out of control. Examples of situations that show up in control charts are:

- Shift in mean - is usually caused by incorrectly prepared standards or reagents, contamination of sample, problems in instrument calibration, or analyst error.
- Trend of mean downward - is usually caused by deterioration of standards or reagents.

- Trend of mean upward - is usually caused by concentration of standard due to solvent evaporation or deterioration of reagents.
- Increase in variability - is usually caused by poor technique by the analyst or deviation from procedure.

4.5.2 Precision is defined as the degree to which a set of observations or measurements of the same property, obtained under similar conditions conform themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (NELAC 2003) Precision is the measure of how closely multiple analyses of a particular sample agree with each other. To determine the precision of the method and/or laboratory analyst, a routine program of duplicate analyses is performed. The results of the duplicate analyses are used to calculate the relative percent difference (RPD), which is the governing quality control parameter for precision. The relative percent difference (RPD) for duplicate analyses is defined as 100 times the difference (range) of each replicate set, divided by the average value (mean) of the duplicate set.

4.5.3 Accuracy is defined as the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS) Accuracy is the measure of the closeness of an observed value to the “true” value (theoretical or reference value or population mean). The accuracy of an analytical method and/or the laboratory analyst is based on the analysis of laboratory control standards. LCS results are used to calculate the quality control parameter for accuracy evaluation, the percent recovery (%R). The %R is defined as 100 times the observed concentration divided by the true concentration of the spike.

4.5.4 Uncertainty can be calculated using the Quality Control based Nested approach as described in SOP QA-013. Uncertainty will only be calculated if requested by the client. The approach uses batch QC over a period of time. This approach can also incorporate sample uncertainty if field QC is available. A minimum of twenty measurements is required.

4.6 Audits and Assessments

Internal audits are scheduled and documented by the QA Department. A member of the QA Department or designee performs the internal audits. All technologies and Departments must be reviewed at least annually. Audits are documented through the use of a method specific checklists and a written report maintained in the QA Department. Internal audits are used to determine if lab activities meet the requirements of GCAL’s quality system, state regulations and TNI standards.

4.6.1 Internal audits are performed ensure that all aspects of the QA program are compliant with state regulations and TNI standards. The QA Manager reviews all information pertaining to the quality system and notes any areas of non-compliance. In addition, observations may be documented in the report. Observations are issues that while compliant with state regulation, TNI standards and GCAL's quality system has the potential to develop into non-compliance in the future. Areas were the analyst's performance exceeds expectation will be noted in the report. The report is prepared based on the audit findings and is distributed to management in a timely manner. The report findings are discussed with the appropriate laboratory personnel and department supervisor so that a concerted effort can be made to correct any non-conformances as well as to provide positive feedback. At a minimum, the QAM or designee will review the following elements of the program annually:

- Sample handling, including custody and storage procedures
- Sample analysis
- SOPs and associated reference methods
- Bench sheets required for the analytical procedure
- Traceability of stock and working standards and reagents.
- Records such as certificates of analysis for reagents and standards, certificates for support equipment, maintenance records, etc.
- Preventive maintenance
- Proficiency Testing
- Training Records
- Project Management
- Report Generation.

4.6.2 SOPs are reviewed annually or during the internal audit process. SOPs are reviewed against the reference method to ensure that the procedure is technically accurate. The analyst performing the analytical procedure is observed and interviewed to determine compliance with GCAL's SOP. Analytical records are reviewed to ensure traceability of the standards and reagents as well as to verify that all analytical observations are being recorded at the time of analysis and that equipment is in working order. Analysts' training records are reviewed to verify that they are accurate and current. Area of non-compliance and observations are reported to management.

4.6.3 Monthly audits are performed to check support system compliance. A member of QA staff performs the audit and a report is issued to the CEO, Laboratory Director, and Technical Services Director. Follow-up and corrective action is performed as necessary. At a minim, the following areas will be reviewed monthly:

- Calibration of support equipment log books.

- Temperature checks for ovens, incubators, refrigerators, and freezers.
- Logbook documentation and review, and use of strikeout corrections.
- Expiration of standards used.
- Sample chain of custody and tracking of samples.
- Re-Extractions.
- Certificate of analysis.
- Equipment maintenance.
- Tag-out policy.
- Storage blank analysis.
- Safety equipment maintenance.
- Standards and Reagents Labeling

4.6.4 When the findings or non-compliances identified during an internal audit cast doubt on the validity or accuracy of a test result, GCAL will initiate the corrective action process and begin an investigation to determine the cause. During the investigation analytical results will be reviewed to determine the effect if any on the data.

4.6.5 Client and regulatory assessments are scheduled through the QAManager. It is GCAL's policy to have all information pertaining to the client or to our scope of accreditation readily available for review by the assessor or assessment team. Client confidentiality will be maintained throughout the assessment process. The QA Manager coordinates and monitors all on-site assessments, reviews all findings, issues a corrective action plan within 30 days after receipt of the assessment report, and follows-up to ensure agreed changes are implemented. All documentation pertaining to an assessment will be kept on file in the QA department.

4.6.6 A management review will be conducted annually. The management staff will review the laboratory quality system and environmental testing activities to ensure suitability, effectiveness, and identify areas of improvement. This is a system wide assessment. The QAManager will write a report summarizing the findings and any new policy decisions. The review will include at a minimum the following:

- Matters arising from the previous review
- Suitability of policies and procedures
- Reports from managerial and supervisory personnel
- Outcome of recent internal audits
- Corrective and preventive actions
- Assessments by external bodies
- Results of inter-laboratory comparisons or proficiency tests
- Changes in volume and type of work
- Client feedback and complaints
- Adequacy of staff, equipment and facilities.
- Personnel including issues and training for new and existing employees

- Quality control activities
- Goals for upcoming year and status of goals from the previous management review

4.7 Nonconformance and Corrective Actions

A non-conformance is any indication or judgment that a product or service has not met the requirements of the relevant specification, contract, or regulation. It is the state of failing to meet the requirements. Corrective action is the action taken to eliminate the causes of an existing non-conformance, to prevent recurrence. Non-conformance identification and corrective action are an integral part of GCAL's plan for quality assurance in sample analysis. Every attempt is made by laboratory staff to comply with any requirements set forth in methods, standard operating procedures, GCAL's Quality Assurance Program Plan, and client or program specific requirements. When non-conformances occur and are not correctable immediately at the bench, the occurrence is documented in the case narrative of the final report and the client is notified of the non-conformance. When errors, deficiencies or out-of-control situations develop, corrective action is initiated. The following non-conformance identification and corrective action programs are used in the laboratory and are described below.

4.7.1 Laboratory non-conformances and corrective actions are documented on a Non-Conformance/Corrective Action Form (NCCAF). NCCAF's are tracked in a controlled logbook and maintained by the QA department. Any GCAL employee that identifies a non-conformance has the authority to initiate corrective action. The corrective action process is initiated by notifying the QA manager, supervisor, or a member of management or the process can be stated by filling out the non-conformance section of a NCCAF and submitting it to the QA manager. Once initiated, it is the responsibility of the QAM to see that a root cause analysis is performed, a resolution is identified and any follow up action determined necessary is completed. If corrective action is determined to be unsuccessful, the process is repeated. When identified non-conformances result in a change to reported data, a corrected report is prepared, the client is notified of the change, and the corrected report is submitted to the client. The corrected report file copy is then attached to the top of the original report file copy.

4.7.2 Sample integrity problems determined at login are documented on a Login Discrepancy Form. The form is completed at the time the discrepancy is noted during the login process and forwarded to the assigned project manager. The assigned project manager will contact the client for instructions on how to proceed with the sample. These instructions are documented on the form. If the client's instructions are to proceed with analysis, the project manage will notify login personnel and the samples will be released for analysis. If the client's instructions state that re-sampling will occur then original samples will be sent for disposal or returned to the client if requested. The Login Discrepancy Form is kept in the report file copy.

4.7.3 On-the-spot or immediate corrective action refers to corrective actions that are taken at the time the non-conformance is identified and usually applies to spontaneous problems, such as an instrument malfunction. This type of corrective action is handled by the analyst at the bench. Any staff member who detects/suspects non-conformance to previously established criteria or procedure in equipment, instruments, data, methods, etc. shall immediately notify the appropriate department supervisor and/or Laboratory Director. In many cases, the staff member will be able to correct the problem. Acceptable on-the-spot corrective actions are defined in SOPs and documented in the appropriate logbooks. Examples include re-analysis of a failing LCS, re-extraction, etc. Trends in re-extracts are monitored. When a trend is identified it will trigger a root cause investigation and corrective action.

4.7.4 Prep non-conformances are documented on a Re-extract Form and are logged and tracked in a controlled logbook maintained in the QA department. Reasons for prep batch re-extraction can include method blank failures, LCS failures, and surrogate failures. Trends in re-extractions are monitored by the QA department. When a trend is identified it will trigger a root cause investigation and corrective action.

4.7.5 If the result of a corrective action or audit cast doubt on the validity of a sample result, the client must be notified within 3 business days. Client notification and further instructions must be documented.

4.8 Customer Inquiries and Complaints

4.8.1 Customer inquiries are received by project managers. If the inquiry requires follow-up action, the project manager fills out a Client Inquiry Form and logs the inquiry into the Client Inquiry Logbook. The inquiry is then sent to the supervisor of the lab or to a member of management for investigation. Following the investigation, a response is recorded on the Client Inquiry Form and the client is notified of the outcome of the investigation. This investigation can include a complete review of the raw data and re-analysis of the sample if applicable. If the inquiry uncovers a lab error and involves further corrective action, the project manager then completes a NCCAF and logs the corrective action into the Corrective Action Logbook. At this point, the corrective action is turned over to the QA department for follow-up and review. If required, the final report is re-issued with the appropriate corrections. The report is marked as resubmitted and the reason for the resubmittal is documented in the case narrative.

4.8.2 The employee that receives a customer complaint forwards the details of the complaint to the QA manager. The details of the complaint must include at a minimum the client/customer, date of complaint, and a description of the issue. The responsible party is identified. The compliant details and the associated corrective action form are sent to the appropriate employee for resolution. Complaints are handled as corrective actions in accordance with SOP GEN-018.

4.9 Service to Clients

GCAL will seek feedback, both positive and negative, from customers in an effort to identify areas where improvement is needed. The customer satisfaction questionaire will be hosted on the GCAL internet site. This feedback will be used to improve our quality system, testing activities, and service to our clientele.

4.10 Management and Control of Change Process

Changes to the Quality system, either temporary or permanent are documented. Controlled documents such as QAPP and SOPs will be reviewed annually and revised when necessary. This will be documented through the use of a revision number, approval date on each document as referenced in QA-001. Approval signatures for SOPs are located in the heading. The QAPP approval signatures are located on the front page of the document. The SOP will include a document review and revision history. Notification of Updated SOP form will be used to document that employees are aware that an SOP has been updated and by signing the form agree to follow the revised/updated SOP. Changes to the LIMS will be documented using the LIMS Change form. Any requested change to the LIMS must have approval from the appropriate supervisor, manager and management. Changes to the LIMS will be made in a test environment and must be completely functional (de-bugged) before the change can be implemented. Employees will be notified of changes to the LIMS and trained on said changes.

5 DATA DOCUMENTATION, VALIDATION, AND REPORTING

Data validation is performed to check data integrity and to verify that the data is correct and of an acceptable quality. Data integrity involves reviewing all documentation for errors and mistakes. It includes review for correct documentation of sample ID's, verification that holding times were met, transcription errors, correct calculations, complete records, and for acceptable chain of custody documentation. A review of the data is performed to verify the results and to assure that all QC is within acceptable criteria. The data is reviewed according to the method specified criteria and according to the client specific project requirements. The reviewer will identify unacceptable data and initiate the appropriate corrective actions. The documentation of data shall be performed in a manner that allows for the historical reconstruction of results by internal or third party validators.

5.1 Recording data

All raw data is recorded in bound log books and/or by instrument printout. This includes calibration, LCS, matrix spikes, duplicates, reagent blanks, calculations, dilutions and any notations concerning a given analysis. If data are recorded by hand, it must be done in ink. It is inappropriate to have pencils, erasers, or correction fluid at the bench for any reason.
Data are kept either as hardcopy, electronically, or both. All instruments with audit trail capabilities will have the audit trail function turned on. Computers used in data capture and instruments capable of password protection will be password protected. Log books used in the laboratory for data capture will be controlled. QA department is responsible for creating and archiving log books. If changes or corrections are necessary to either hard copy or electronic data, it must be performed in a way that maintains the original observation and the integrity of the data. Changes made to hard copy data will require the analyst to use a single line strike though, initial and date, and the reason for the correction if other than transcription error. If the record does not allow space to clearly show the change, write it in the comments section of the log book or at the bottom of the page. If electronic files must be changed, the file must be renamed so that the original data is not lost. Reasons for doing so must be written in the comments and/or fully documented using a correction form. At no time shall data be obliterated for any reasons.

Electronic data is backed up and protected by the IT Department. All schedules and procedures are fully documented in IT SOPs.

5.2 Data Reduction

Data reduction includes all activities that convert instrument/computer responses into reportable results. This involves all calculations and compound identification. Final results are obtained by direct reading from the instrument or calculations based on instrument readings, output, or responses. Manual data reduction is performed by calculating results with the appropriate formula. Manually entered information is reviewed for accuracy on the hard copy. Computer data reduction requires that the analyst verify information used in final calculations is entered accurately. The analyst must also review the raw data for properly identified components, possible interferences, confirmation requirements, and acceptable readings for integrations.

5.3 Data Review

5.3.1 All data undergoes an extensive review process. The analyst performs the first level data review and validation. Data is uploaded or manually entered into the LIMS. The first level reviewer will verify that:

- the calibration meets SOP and or project criteria and frequency, and the calibration supports the required detection limit.
- all reagents and standards used are within expiration date.

- the method blank meets acceptance criteria.
- the appropriate QC has been performed and meets acceptance criteria.
- dilutions were performed as necessary, and the reason documented.
- there isn't anything unusual about the sample that is affecting the data. This includes submitted duplicates that are obviously different, presence of interference, analysis past hold time, etc.
- all documentation is complete and accurate.

Refer to SOP QA-002 for more details on analyst review.

It is the analyst's responsibility to document any problems and communicate these to the supervisor, department manager or Lab Director. If an immediate solution is not found, such as one re-analysis of QC that passes criteria, the problem(s) must be communicated to the Laboratory Director, Technical Director, and/or QA Manager. An Analyst is not authorized to continue with an analysis if the calibration or QC results do not meet the acceptance criteria established by the SOP or project. Notify the supervisor, department manager or Lab Manager immediately and start the corrective action process. Samples shall be held until further documented instructions are received.

5.3.2 Second Level data review and validation is performed by the department manager or their designee. Data is validated in the LIMS. The second level reviewer will verify:

- that the data meets SOP and/or project requirements, including acceptance criteria, frequency of calibrations, frequency of QC samples, and detection limits.
- the data for the analytical group is logical. For example nitrite is not greater than nitrate + nitrite.
- that all calibration or QC failures are clearly described in the batch exception reports. This includes descriptions of allowed failures such as the number of marginal exceedences allowed for the LCS.
- that dilutions are described in the batch exceptions report.
- that times and dates are logical and correct.
- that documentation is accurate and complete so that the data can be reconstructed based on the information provided.
- that the appropriate standards and reagents were used for their intended purpose.
- all storage and preservation requirements were met or non-compliances fully described.
- that data is consistent with historical results when available.
- that results are within permit requirements when known.
- that calculations are correct.
- that manual integrations are appropriate and documented.

Refer to SOP QA-002 for more details on second level supervisor review.

5.4 Data Validation

After the complete package is assembled, the report validation manager or designee will review the data. The level three reviewer will verify:

- that the correct package has been prepared.
- that the package is complete and includes all requested analysis, forms, reports, chain of custody, and raw data as appropriate.
- that project specific data quality objectives and/or GCAL's requirements have been achieved.
- that exceptions and any information that can impact the data are clearly identified in the case narrative.
- that data is flagged appropriately and that the data flags are clearly defined.
- that raw data and data reports are consistent.
- that all samples associated with the have been analyzed and that the sample IDs are correct.
- that reporting limits are supported by the calibration.
- that dilution schemes are justified and correct.
- that all calculations are correct.

If problems or questions are identified during the third level review, a corrective action form must be completed. The corrective action form and the report are sent back to the appropriate supervisor(s) or manager for review and correction. Once the department manager or supervisor has completed this review and correction, the report is returned to the validator. All steps are documented using the corrective action form. Once complete the corrective action form is returned to QA/QC department. The corrective action is reviewed and approved by the QAM.

5.5 Data Reporting

Hardcopy and electronic reports are the products of the GCAL. It is therefore imperative that the report accurately and completely reflects the results determined by the lab. Any modifications or departures from GCAL's SOPs will be clearly communicated in the report through the use of data qualifiers and the case narrative.

When all requested analysis have been reviewed and validated by the supervisor(s) a preliminary report may be sent via e-mail if requested by the client. The preliminary report is subject to change if the third level review of the data indicates a problem. The client will be notified of any changes in the preliminary report as soon as changes are identified and the report corrected. The final report will then be printed. GCAL has the capabilities to produce several levels of reports and electronic data deliverables. These include a LIMS report with batch QC, a CLP like forms package, a full CLP like deliverable package, and various other formats. The client specifies the level of reporting when the samples are submitted.

After the reports have been authorized and signed by the Report Validation Manager or designee the reports are sent to the project manager for release to the client. The QA Manager or designee must review a minimum of 10% of all federal program reports, including DOD/AFCEE packages. The QA review is performed following the release of the final report outside of the day-to-day process. The project manager is responsible for checking that the report level is correct and that the report has been signed. After final approval of the reported data, various electronic data deliverable can be produced to submit data electronically. Refer to SOPs LAD-003 and QA-003 for more details on assembling final reports, reviewing final reports, and QA review.

5.5.1 All test reports include the following:

- A cover page that includes a title, "Analytical Results", name, address, and telephone number of the laboratory, work order number which uniquely identifies the report, and the name and address of the client, contact, and project name, and NELAP certificate number,
- GCAL contact person for questions,
- Sequentially numbered pages with the total number of pages written in the Laboratory Endorsement page, or numbered as # of # (for example 1 of 50),
- Signature of Data Validation Manager or designee,
- Statement that the report relates only to the samples reported,
- Statement that the report shall be reproduced only in full and with the written permission of GCAL,
- Case narrative indicating any anomalies, method or QC failures during sample analysis,
- A report sample summary including the sample ID, lab ID, matrix, and collection and receipt date/time.
- The test results that include prep and analytical methods, prep and analysis date and time, prep and analysis batch, weight or volume of sample prepped/analyzed, units, indication of dry weight correction where applicable, results, reporting limits, and data qualifiers,
- QC summary with qualifiers as appropriate, and
- Chain of custody, log-in check sheets, and log-in discrepancy form where applicable.

5.5.2 Additional information shall be provided to clients when requested through reports. This information includes:

- Copies of raw data and logbook entries for submitted analysis,
- Instrument calibration summary and raw data,
- Method detection limits,
- Summaries for surrogate recoveries, internal standards, instrument tune, and method blank summary,

- Manual Integration Summary
- Additional information as requested.
- Identification of sub-contracted work.

5.6 Sub-contracting

Laboratories that GCAL sub-contract to will be reviewed with an emphasis on their overall quality control practices and compliance to GCAL's quality assurance requirements. GCAL bears the responsibility for all sub-contracted work performed by a sub-contractor we select. Any laboratory used for subcontracting must be certified or accredited if required for the project and documentation of such must be kept on file. The QA/QC Department or project manager will submit a request to the lab to provide verification of certification or will notify the appropriate accrediting authority to verify certification. Project requirements must be communicated to the sub-contracted lab in a timely manner. When data is received it is reviewed by report validation. GCAL will facilitate any client comments or complaints regarding sub-contracted data. The sub-contract laboratory must have successfully completed an assessment by the applicable DOD Environmental Laboratory Accreditation Program (ELAP) component (AFCEE, Army Corp, etc.) for use in all DOD work. The sales representative and project manager verifies compliance with the DOD QSM or other project criteria before the start of the project. Records of compliance must be supplied by the sub-contracted lab and kept on file. If testing is sub-contracted to another laboratory, the client will be notified in writing.

5.7 Data Storage

The laboratory will retain all records related to sample analysis including raw data, calculations, derived data, calibrations and copies of test reports. These records are archived in accordance with regulatory requirements for a minimum of ten years or as required by specific client contracts. In the event the laboratory goes out of business, clients will be notified at least 60 days (time permitting) prior to closure of the laboratory and will receive final reports for all submitted samples. The client notification will request instructions on the retention or distribution of laboratory records and will provide contact information to be used after the laboratory closes. Software/hardware required to access electronic data will be maintained.

A copy of client reports is stored either electronically or a hard copy is stored in a room requiring key-card access. All reports must be signed out using the archived reports logbook. Client reports and chain of custodies are scanned for electronic storage. All archived logbooks, corrective actions, PT results, training records, and other QA/QC reports are stored in a secured storage area. Written and printed data records (bench sheets, logbooks, electronic printouts, etc.) are scanned before being boxed and placed in storage. Electronic data is stored on a dedicated server. This server is backed-up daily. Approximately 1 year of electronic data is accessible at workstations. Data removed from the servers and stored on tapes can be reloaded by submitting a request to IT. The safety/compliance officer keeps safety and disposal records. The Comptroller is responsible for keeping personnel information in controlled files.

Archived data is stored on-site until capacity is met. The oldest archived data is then moved to a secure storage facility. The storage and on-site facility are monitored and protected from fire and theft. Electronic data storage is free from magnetic sources. It is the goal of GCAL to have redundant copies (hard and electronic) to prevent loss of records due to records being misplaced, environmental deterioration or catastrophe.

6 FACILITY DESCRIPTION AND EQUIPMENT

6.1 Laboratory Facilities

GCAL is a full service environmental laboratory. The laboratory was established in 1979 with a staff of two and has grown to its present size of over 70 employees operating in a modern laboratory space of 20,000 square feet.

The laboratory's working areas are subdivided into areas for instrumental analysis, wet chemistry and sample preparation. These areas are designed to allow for a safe and comfortable working environment with special attention having been given to ventilation, airflow patterns and environmental controls. Administrative and Marketing areas are located for optimization of supervision and to allow for efficient handling of paperwork and results. The laboratory is protected by a video monitoring system and fire monitoring system. A floor plan of the facility is included in Appendix D.

6.2 Procurement and Inventory Control

Chemical reagents, solvents, gases, glassware and general chromatographic supplies are ordered as needed to maintain sufficient quantities on hand for use. Purchase orders are maintained as an inventory control of materials ordered by the laboratory. All orders are processed through central receiving and routed to the appropriate departments. Routine supplies are maintained on site in an inventory control stock room.

The purchase of analytical instrumentation is based on anticipated sample volume and the need to maintain superior quality data. Specifications are carefully examined to be sure new instrumentation meets current and anticipated needs. Warranty and service contract information is gathered at the time bids are reviewed and this information is considered in making the final selection. An extensive performance check-out before the instrument is accepted is mandatory. New equipment must undergo a rigorous method validation before being put into production. Operators of new instruments are sent to training courses if necessary.

Inventory records are maintained for all major capital equipment. Major suppliers of consumable items are:

Allometrics	Templet & Templet	Dionex
Fisher Scientific Company	Supelco	CPI
Environmental Express	Perkin-Elmer	Shimadzu

6.3 Capital Equipment

Laboratory equipment and instrumentation are maintained in compliance with instrumentation manuals. All equipment is kept in working condition to allow for conformity to each approved method. The key instrumentation such as Gas Chromatography, Gas Chromatographs/Mass Spectrometers, ICP, ICP-MS and Atomic Absorption Spectrometers has maintenance contracts with their respective suppliers. A list of instrumentation and equipment is maintained by the QA/QC Department and is included in Appendix C.

6.4 Equipment Operation and Calibration

Equipment is defined as any non-disposable mechanical and/or electronic device used in the generation or measurement of data.

6.4.1 The calibration of instruments and support equipment is required to ensure that the analytical system is operating correctly and functioning within acceptable precision, accuracy and sensitivity limits. Calibration is defined as the systematic determination of the relationship of the response of the measurement system to a known standard. The calibrations or calibration checks are performed with reference standards traceable to primary standards (e.g. NIST or other certified standards). If traceable chemical standards are not available, standards are prepared according to the laboratory quality control procedures or the project's requirements. The calibration requirements for each type of equipment or instrument are defined in the standard operating procedures. Additionally, specific requirements are defined in a project plan. Table 6-1 summarizes the calibration requirements of the lab.

6.4.2 It is the responsibility of the analyst to verify that the instrument configuration and operating conditions used satisfy the analytical requirements and to maintain quality control data confirming instrument performance and analytical results. The inability to achieve calibration is an indication that the equipment needs maintenance. It is not acceptable for an analyst to repeat analysis of calibration or QC standards beyond what is allowed by the SOP until “acceptable” results are achieved.

6.4.3 If equipment outside the permanent control of the laboratory is used, it must meet the same criteria. The laboratory shall ensure that the function and calibration status of the equipment is checked and shown to be satisfactory before it is put into service. The equipment must meet all requirements of LADEQ regulations/TNI standards.

6.5 Equipment Maintenance

Maintenance is defined as cleaning and/or replacing equipment components to assure that the equipment has been properly and periodically serviced and is in satisfactory condition. The equipment manual is a good guideline to determine preventive and routine maintenance schedules. These manuals also assist in identification of commonly needed replacement parts so that an inventory of these parts can be properly maintained.

6.5.1 A maintenance log is issued for each piece of equipment. It shall be maintained by the analyst to describe problems, the maintenance performed on the instrument and outcome. This includes routine service checks by laboratory personnel (unless described in the SOP) as well as factory service calls. This log also provides a written source for future use in preventive maintenance. The equipment maintenance logs are reviewed monthly by a member of QA department.

6.5.2 In order to prevent system down time, minimize corrective maintenance cost and to help insure data validity, GCAL uses a system of preventive maintenance. All routine maintenance is performed as recommended by the manufacturer. Maintenance contracts are purchased as appropriate. This insures preventive maintenance visits by factory authorized service representatives and immediate service for corrective actions if required.

6.5.3 When a piece of equipment is deemed defective, it is taken out of service and identified with an "OUT OF SERVICE" label that includes the date the equipment was taken out of service. For support equipment such as balances, ovens, coolers, and pipettes, the QA/QC Department is notified so that repair can be scheduled. Analysts perform routine and preventive maintenance for instruments and document the maintenance in the appropriate equipment log book. If outside service is necessary, the Department Supervisor schedules the service with approval from the Laboratory Director. Satisfactory instrument performance must be verified prior to returning to service any repaired equipment.

6.5.4 Table 6-1 is a list of support equipment calibration frequencies. In addition to the stated frequencies, calibrations are performed prior to first use and upon evidence of deterioration. Class “A” glassware is only verified upon evidence of deterioration. Calibration acceptance is based on 10 replicates. Refer to SOP GEN-010 for more details.

Table 6-1 Equipment Calibration

Equipment	Calibration*	Frequency
Analytical Instrument	Traceable standard	Each day of use or as required by instrument manual
Oven and Refrigerator	Calibrated thermometer	Each day of use
Thermometers	NIST Thermometer	Annually (Mercury), Quarterly (Digital)
NIST Thermometer	Certified off-site	As required by certificate
Balance	Certified weights	Each day of use, certified semi-annually
Weights	Certified off-site	As required by certificate
Adjustable pipettes	Weight	Each day of use
Non standard lab ware	Weight	By lot
Non-class A volumetric	Weight	Quarterly
Agitators (TCLP, SPLP)	Stop watch	Monthly

* Acceptance criteria are included in log books used to document verification or maybe found on the certificate affiliated with the thermometer, weights or stop watch.

6.6 Reagents

6.6.1 All solvents used for preparation of standards must be of acceptable purity to not interfere or invalidate the test. Purity of reagents must meet the reference method requirements and must not invalidate the test as shown by the acceptability of method blanks.

6.6.2 Reagents must be stored as specified by the manufacturer, and must be disposed of after the expiration date. If no expiration date is supplied, label acids and bases for five years from receipt, and other reagents as one year from receipt.

6.6.3 Neat chemicals must be stored as specified by the manufacturer, and must be disposed of after the expiration date. If no expiration date is supplied, label the neat chemicals for 10 years from receipt.

6.6.4 All reagents must be in labeled bottles with the date of receipt and date opened marked in permanent marker.

6.6.5 Reagent water is available throughout the lab. GCAL uses de-ionized water supplied by Siemens. In addition for ICP-MS analysis the DI water is treated using a Millipore Synergy UV system to further enhance water quality. GCAL has 4 supply systems that provide water throughout the facility. The water resistivity is monitored daily at three of the supply systems. The fourth system is for the dishwasher and is monitored by the light system provided by Siemens. Each of the remaining three supply systems have various stations assigned to them. Resistivity is checked at one of the stations for each of the systems daily. Should the resistivity fail at any one of the stations for a supply system the entire system will be taken out- of- service. Siemens supplied lights are monitored each morning and Siemens will be notified when service is necessary.

6.7 Standards

Preparation of standards for calibration or QC must be made from materials of known purity, (98% or better preferred) or from purchased concentrates certified by NIST, EPA, or other acceptable agencies.

6.7.1 An expiration date of one year from the date received will be assigned to all stock standards without a manufacturer's specified expiration date. Upon receipt into the laboratory, a unique identification number (ID) is assigned to the standard. The following information is recorded standard container: laboratory assigned ID, standard name, concentration, initials of the analyst opening the standard, date opened, and expiration date. All other information regarding the standard including lot number, the analyte purity, expiration date, concentration, must be entered in the standards log maintained by the QA department.

6.7.2 Preparation of intermediate or working standard solutions is necessary for many tests. These working standards include calibration standards, spiking solutions, surrogate solutions, internal standard solutions, etc., and must be stored as suggested by the manufacturer when not in use. Working standards for the analysis of volatile organic constituents must be prepared every two weeks or more often if required by the method or if performance is compromised. Working standards for the analysis of semi-volatile organic constituents and pesticides are prepared as needed and expire 6 months from the date prepared or no later than the expiration date on the stock standard whichever is sooner.. Working standards for trace metal analysis are prepared at least monthly and have a concentration of 1 mg/L and less. Calibration standards for mercury are digested as needed and calibration standards for graphite furnace are prepared daily. Working standards expiration dates cannot be longer than the expiration date of the parent standard or reagents used. Standard expiration may be extended by approval of the QA Manager in an emergency. Acceptable performance must be demonstrated and documentation kept on file. Prepared working standards are verified by comparison to response from the previous calibration as described in SOP GEN-006.

6.7.3 The identification of each standard prepared must be unique and all documents related to sample analysis in which the standard was used must contain this unique identification. The documentation shall be such that traceability ofall of standards and reagents used is maintained and can be related to raw data from sample analysis..

6.7.4 Freezers and refrigerators are designated for storage of standards. Samples are not stored with standards. Refrigerators or freezers used for storage of standards or samples are monitored for temperature compliance seven days a week. Refrigerators are maintained at $<6^oC$ and $>0^oC$. Freezers are maintained between -10^oC and -20^oC.

7 ANALYTICAL METHODS

GCAL utilizes methods of analysis that provide evidence of analyte identification, separation from interfering substances, limits of measurement appropriate to that of analyte concentration and reasonable measures of precision and accuracy of the data obtained. Depending upon the analysis requested and the sample matrix, the methods used are official, standard or reference, screening, or modified. Analyses will be performed in accordance with the methods cited herein unless specific project requirements or needs dictate adoption of an alternate method or modification of the cited methods. Modification of a method due to sample matrix shall be discussed with and authorized by the client.

If analysis is performed in an alternate manner, the method shall be documented. Documentation is dependent upon the specific instrumentation and data collection and reduction methods used within the lab. Methods used directly from official or standard procedures are referenced as such. Routinely used procedures are available in each department and are also available electronically. Official protocols are used when required or requested.

7.1 Method Validation

Before the performance of methods for reporting to client, each method must be validated. This shall include achieving acceptable calibration and a demonstration of capability. Any work that is performed for government or regulatory purposes shall also have an acceptable limit of detection (LOD) or method detection limit (MDL) study before samples are reported.

7.1.1 Every instrument used to determine results for client samples or QC shall be appropriately calibrated daily before each use. Calibration shall include an initial calibration and continuing calibration as defined in the reference method and described in the SOP. Acceptable performance as defined in the reference method/SOP shall be shown before proceeding with sample analysis. Initial calibrations are verified using an independent standard. Additionally the following shall apply to all calibrations performed:

- Raw data shall be retained to allow reconstruction of the calibration and process to reduce instrument response to concentration. Records shall also include the analyst, date performed, and instrument.
- Samples and QC shall be quantitated using the initial calibration unless the cited method uses alternative procedures.
- The calibration range shall define the working range of the instrument with the exception of metals analysis. For all other analysis the low level standard defines the lowest reporting limit (PQL or LOQ) that is reported to a client. For metals a zero and one point calibration is used. High and low-level checks shall also be included as required by the project or method.
- Sample results exceeding the concentration range (or linear range for metals analysis) shall be diluted.
- The analyst is allowed to drop points out of a calibration curve at the high and/or low ends of the calibration curve if the minimum number of points and the project required detection limits are maintained. Points shall not be removed from the middle of a calibration unless there is a documented reason. The analyst is allowed to re-analyze and replace the suspect point within the same analytical batch or remove the point for all analytes with approval from the QA Manager, Technical Services Director or Laboratory Director.

7.1.2 Before the implementation of a test method or analyte to a test method, a satisfactory demonstration of method capability is required. This shall include the analysis of four LCS samples with acceptable accuracy and precision. Accuracy and precision is generally defined in the test method. Thereafter, each analyst shall perform a demonstration of capability as part of their initial training and annually. This demonstration shall include acceptable performance in one of the following:

- Acceptable performance of a blind sample;
- A demonstration of method capability; or
- Performance of four consecutive LCS samples with acceptable precision and accuracy.
- If the first three cannot be performed, analysis of samples with results statistically indistinguishable from a trained analyst.

All demonstrations shall be documented on the certification statement form and maintained in the analyst’s training filed by the QA/QC Department.

7.1.3 A low-level check standard shall be performed at 1-2X the reporting limits. The recovery of this check standard must meet method defined LCS criteria, or lab derived limits if not defined by the method. Alternatively an LOD check shall be performed meeting the criteria of SOP QA-009.

7.1.4 Method detection limit studies shall be performed using 40CFR Part 136 Appendix B. All MDL/LOD are verified using NELAC limit of detection requirements. See SOP QA-009 for a full description of MDL/LOD requirements.

7.1.5 Precision and accuracy of measurement shall be monitored as an ongoing method validation measure. Control charts shall be generated at least annually and control limits updated and compared to method or laboratory historical limits. A copy of the control chart shall be kept on file in the QA/QC Department.

7.2 Methods Outside of Scope of Accreditation

Occasionally a client will request analysis for informational or non-regulatory purposes. Work outside of the scope of accreditation does not require validation in the same manner as other analysis. Method development will be discussed with the client to meet the client's needs. A letter stating the intent of the work shall be obtained from the client and kept on file.

Reports issued outside of the scope of accreditation shall be identified. This identification shall include either the removal of the LELAP certification number, or, in the case of a mixed report, those methods outside of the scope of accreditation shall be clearly stated in the case narrative.

7.3 Review of New Work

For the laboratory to perform additional work within its scope or to expand its scope of testing a thorough review must be undertaken. Laboratory management considers available resources and current and pending workload prior to accepting new work.

It is the responsibility of the Laboratory Director, with input from the Technical Services Director, and department supervisors to assess the ability of the laboratory to accept new work.

Before new work is accepted the QAManager must assess the accreditation needs and obtain all necessary certifications.

7.4 Analytical Methods

The analysis performed at GCAL is listed in the following Tables.

Organic Tests Performed		
Analyte (Parameter)	**Method**	**Reference**
Aromatic Volatile Organics	8021B 602	2 6
Explosives	8330A	2
Organochlorine Pesticides	608 8081B	6 2
PCBs	8082A	2
TPHG	8015C	2
TPHD	8015C	2
GRO	8015C	2
DRO	8015C	2
ORO	8015C	2
Petroleum Range Organics	Fl-Pro	10
Total Petroleum Hydrocarbons	TX1005/TX1006	13,14
EPH	Massachusetts	15
VPH	Massachusetts	16
Organophosphorus Pesticides	8141A	2
Chlorinated Herbicides	8151A	2
Dissolved Gases	RSK175	9
GC/MS Semivolatile Organics	625 8270C, 8270D	6 2
GC/MS Volatile Organics	624 8260B	6 2
GC/MS SIM Semivolatile	625 8270C, 8270D	6 2
HPLC PAH's	8310	2
Solvents	8015D	2
Alcohols	8015D	2
Methanol	94.03/99.01,HAPC 8015D	11 2
Extractions and Preparations		
TCLP	1311	2
SPLP	1312	2
Separatory Funnel	3510C	2
Liquid/Liquid	3520C	2
Ultrasonic	3550C	2
Waste Dilution	3580A	2

Organic Tests Performed		
Analyte (Parameter)	**Method**	**Reference**
Soxhlet	3540C	2
Purge and Trap	5030B, 5030C	2
Closed System Purge and Trap	5035A	2

INORGANIC TEST PERFORMED		
Analyte (Parameter)	**Method**	**Reference**
Metals		
Aluminum ICP ICP-MS	 200.7 6010B, 6010C 200.8 6020A	 7 2 7 2
Antimony ICP ICP-MS	 200.7 6010B, 6010C 200.8 6020A	 7 2 7 2
Arsenic GFAA ICP ICP-MS	 7010 200.7 6010B, 6010C 200.8 6020A	 2 7 2 7 2
Barium ICP ICP-MS	200.7 6010B, 6010C 200.8 6020A	7 2 7 2
Beryllium -ICP	200.7 6010B, 6010C	7 2
Boron -ICP	200.7 6010B, 6010C	7 2
Cadmium -ICP	200.7 6010B, 6010C	7 2
Calcium -ICP	200.7 6010B, 6010C	7 2
Chromium -ICP	200.7 6010B, 6010C	7 2
Chromium VI -Colorimetric	7196A 3500Cr D	2 3
Cobalt	200.7	7

INORGANIC TEST PERFORMED		
Analyte (Parameter)	**Method**	**Reference**
-ICP	6010B, 6010C	2
Copper -ICP	200.7 6010B, 6010C	7 2
Iron -ICP	200.7 6010B, 6010C	7 2
Lead -ICP	200.7 6010B, 6010C	7 2
Magnesium -ICP	200.7 6010B, 6010C	7 2
Manganese -ICP	200.7 6010B, 6010C	7 2
Mercury CVAA	245.1/245.2 7471B 7470A	1 2 2
Molybdenum -ICP	200.7 6010B, 6010C	7 2
Nickel -ICP	200.7 6010B, 6010C	7 2
Potassium -ICP	200.7 6010B, 6010C	7 2
Selenium -GFAA -ICP	 7010 200.7 6010B, 6010C	 2 7 2
Silver -ICP	200.7 6010B, 6010C	7 2
Sodium -ICP	200.7 6010B, 6010C	7 2
Strontium -ICP	200.7 6010B, 6010C	7 2
Thallium -GFAA -ICP	 7010 200.7 6010B, 6010C	 2 7 2
Tin -ICP	200.7 6010B, 6010C	7 2
Titanium -ICP	200.7 6010B, 6010C	7 2
Vanadium	200.7	7

INORGANIC TEST PERFORMED		
Analyte (Parameter)	**Method**	**Reference**
-ICP	6010B, 6010C	2
Zinc -ICP	200.7 6010B, 6010C	7 2
Zirconium -ICP	200.7 6010B, 6010C	7 2
Metal Preparation Methods		
Acid Digestion Aqueous and ICP	200.7 3010A	7 2
Acid Digestion Aqueous GFAA	200.9 3020A	1 2
Acid Digestion Solids	3050B	2
Microwave Assisted Acid Digestion Solid and Organic	3051A 3052	2
TCLP	1311	2
SPLP	1312	2
Wet Chemistry		
Acidity	2310B	3
Alkalinity	2320B	3
Ash	D482	4
BOD/BODC	5210B	3
Bromide	300.0 9056A	1 2
BTU-Heat of Combustion	D240-92	4
Cation Exchange Capacity	LADNR 29B	17
COD	HACH 8000/8328	5
Corrosivity	1110A 9040B/4500 H B 9045C	2 2 2
Chloride	SM 4500Cl E 300.0 9056A 9251	3 2 2 2
Residual Chlorine	4500-Cl G	3
Fecal Coliform	9222D	3
Color	2120 C	3
Conductivity	2510B 9050A	3 2
Corrosivity Toward Steel	1110A	2
Cyanide -Free -Total	 335.4 335.4/ 9012A	 1 1 2

INORGANIC TEST PERFORMED		
Analyte (Parameter)	**Method**	**Reference**
-Amenable to Chlorination	335.4/ 9012A	1 2
Density	2520C	3
Fluoride	4500F-D/300.0 9056A	3,1 2
Hardness Calculation	2340B	3
Ignitibility	1010A 1030	2 2
% Moisture	SW846 Dry Weight/2540B	2
Nitrogen -Ammonia -Kjeldahl -Nitrate -Nitrite -Total Nitrate Nitrite	 4500NH_3BE 4500NH_3BF 4500NH_3BE 4500NH_3BF 300.0 9056A 353.2 300.0 9056A 353.2	 3 3 3 3 1 2 1 1 2 1
Oil and Grease	1664A 9071B	8 2
Oxygen, Dissolved	4500 O G 4500O-C	3 3
Paint Filters Liquid Test	9095A	2
Phenolics	420.1/420.4 9066	1 2
pH	4500-H^+B 9040B 9045C	3 2 2
Phosphorus -Orthophosphate -Total Phosphorus	 4500PE 365.1	 3 1
Reactivity -Cyanide -Sulfide	 7.3.3.2 7.3.4.2	 2 2
Silica, Dissolved	4500Si-D	3
Solids -Total Dissolved -Total Suspended -Total Solids	 2540C 2540D 2540B	 3 3 3

INORGANIC TEST PERFORMED		
Analyte (Parameter)	**Method**	**Reference**
-Total Volatile Solids -Volatile Suspended Solids -Setteable	2540E 2540E 2540F	3 3 3
Specific Gravity	2710F	3
Sulfate	300.0 9038 9056	1 2 2
Sulfide	$4500S^2D$ 9034	3 2
Sulfite	$4500\ SO_3^{2-}B$	3
Surfactants -Ionic (MBAS) -Non-Ionic (CTAS)	 5540C 5540D	 3 3
Total Organic Carbon (TOC)	5310B 9060	3 2
Total Organic Halides (TOX)	9020B	2
Turbidity	180.1 2130B	1 3
Viscosity	D445	4
Perchlorate	314.0	12
Sample Preparation Procedures		
Alkaline Digestion Cr^{6+}	3060A	2
Bomb Prep Method for Solid Wastes	5050	2
Distillation Sulfides	9030B	2
SPLP	1312	2

METHOD REFERENCES

1) EPA 600 4-79-020, Methods For Chemical Analysis of Water and Wastes, 1983, second printing. Methods for the Determination of Inorganic Substances in Environmental Samples (EPA/600/R-93/100)

2) EPA SW-846, Test Methods for Evaluation Solid Waste, 3rd Edition, Update I dated 7/92, Update II dated 9/94, Update IIA dated 8/93, Update IIB dated 1/95, Update III dated 12/96, Update IV dated 1/08.

3) APHA/AWWA/WPCF, Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992, Online Edition.

4) ASTM, American Society for Testing & Materials.

5) Hach Company, EPA Approved Procedures for Water and Wastewater, 1986.

6) 40 CFR Part 136 Appendix A, Test Procedures for Analysis of Organic Pollutants

7) Method 200.7, Determination of Metals and Trace Elements in Water and Wastes By Inductively Coupled Plasma-Atomic Emission Spectrometry, Revision 4.4, EMMC Version, May 1994.

8) EPA-821-R-98-002, USEPA Office of Water Analytical Methods; Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry, February 1999.

9) EPA Standard Operating Procedure

10) Florida Department of Environmental Protection, Method For Determination of Petroleum Range Organics, FL-PRO, Revision 1, November 1995.

11) NCASI Method DI/MEOH-94.03, Methanol in Process Liquids by GC/FID, May 2000 and NCASI Method DI/HAPS-99.01, Selected Haps in Condensates by GC/FID, February 2000.

12) NERL, Office of Research and Development, EPA; Method 314.0, Determination of Perchlorate in Drinking Water Using Ion Chromatography, Revision 1.0, November 1999.

13) TNRCC; Method 1005, Total Petroleum Hydrocarbons, Revision 03, June1, 2001.

14) TNRCC, Method 1006, Characterization of Nc_6 to Nc_{35} Petroleum Hydrocarbons in Environmental Samples, Draft

15) Massachusetts Department of Environmental Protection, Method for the Determination of Extractable Hydrocarbons (EPH), Revision1

16) Massachusetts Department of Environmental Protection, Method for the Determination of Volatile Hydrocarbons (VPH)

17) LA DNR 29B, Procedures for Analysis of Exploration and Production Waste.

8 SAMPLE CUSTODY AND INTEGRITY

GCAL utilizes a Laboratory Information Management System (LIMS) that was specifically developed for the needs of environmental laboratories. Horizon©, developed by Chemware, Inc., tracks samples and data throughout the laboratory. Results are available from the LIMS in a variety of hard copy formats. Furthermore, web access can be provided to clients who wish to view their data. A password security system prevents clients from viewing any data other than their own.

The following is an example of some of the information that is entered into the system:

1. Sample number (unique to this sample)

2. Job number (unique to this job or set of samples)

3. Date received

4. Time received

5. Date analytical results due

6. Sample description

7. Customer's name

8. Customer's address

9. Group number

10. Storage location

11. Notation of any special handling instructions or priority assignments

12. Billing information - purchase orders

13. Analyses requested

GCAL understands that sample integrity is a vital part of Quality Assurance. Samples submitted to the laboratory shall be logged in immediately, or other action taken to preserve integrity of the sample until it can be logged into the system. Any sample that is suspected of being contaminated, improperly stored or preserved, or improperly prepared, shall be reported to the client immediately. Storage blanks located in the volatiles refrigerators are analyzed every two weeks. Records of these analyses are maintained in the GC and GC/MS Volatiles laboratories. No sample is analyzed if there is a question concerning its integrity.

After the sample analyses are complete and the final report is issued to the client, samples are held for 60 days from receipt before disposal. Samples are held longer per the customer request. GCAL does not accept evidentiary samples.

8.1 Sample Acceptance Policy

Delivery of samples to GCAL shall constitute acceptance by Client of these Terms and Conditions. Until GCAL accepts delivery of samples by notation on a chain of custody document or otherwise in writing, GCAL is not responsible for loss of or damage to samples. GCAL, at its sole discretion, reserves the right to refuse or revoke Acknowledgment of Receipt for any sample due to insufficient sample volume, improper sample container, or risk of handling for any health, safety, environmental, or other reason. GCAL does not accept samples that contain asbestos, biohazards, or radiological materials. Regardless of prior acceptance, GCAL may return samples at its sole discretion if it is determined that the samples may pose a risk in handling, transport or processing, for any health, safety, environmental or other reason. GCAL also reserves the right to return excessive sample volume to the Client, at the Client's expense.

Samples not consumed in testing will normally be retained for a maximum of sixty (60) days before disposal. Samples will be returned to the Client when requested in writing or when they would pose a disposal problem as a hazardous waste as determined by GCAL, at its sole discretion. The cost of returning samples will be invoiced to the Client. GCAL, in its sole discretion, may also agree in writing to retain samples at a monthly storage charge, agreed upon and payable in advance.

If the Client is ordering the work on behalf of another, the Client represents and warrants that the Client is the duly authorized agent for the purpose of ordering and directing said work unless otherwise stated in writing, and accepted by GCAL.

Sample acceptance policy is sent out with bottle orders in an effort to make sample collection personnel aware of GCAL's policy prior to sampling. Sample acceptance policy is also available electronically upon request.

8.2 Chain of Custody

A complete chain of custody is maintained by GCAL. Each sample when submitted to our laboratory is accompanied by a Chain of Custody form. These forms contain pertinent information about the sample including specific analytical requests, sampling notes, sample condition, customer name and address.

Additionally, information concerning the site name, field identification marks, date and time of collection, sampler signature, and preservation data is recorded.

Samples are labelled, preserved if necessary and stored appropriately (i.e. refrigerator, freezer or shelf). Samples to be analyzed for volatile organic compounds are stored in refrigerators located in the volatiles analytical laboratories.

8.3 Internal Chain of Custody

Samples labels include a bar code. All samples must be scanned each time custody of the container changes. This information is stored in the LIMS, and includes a complete record of the sample custody from receipt to disposal. Information includes the location of the sample, the date and time of each custody transfer, unique initials of each person assuming custody, and a reason for the transfer.

8.4 Custody Transfer

If a sample requires additional work to be performed by a qualified outside laboratory, a GCAL chain of custody form is completed and submitted with a representative portion of the sample. A copy of this form is maintained on file. The sub-contracted laboratory must sign and date the COC upon receipt and return it, along with any unused sample, once analysis has been completed.

8.5 Sample Kits

Customers will request a sampling kit (bottles, vials, etc.) with which to collect samples. Sample kits are prepared according SOP SAD-003. Chain of Custody (COC) forms are sent with the kit to insure proper sample custody. The COC form is completed at the time of sample collection and is returned with the samples. A record of sample kits prepared for clients is maintained by Login personnel.

8.6 Shipping Requirements

The Department of Transportation (DOT) regulations shall be used for packaging and shipment. Shipping containers shall be secured using impact strapping material. Copies of the signed Chain of Custody (COC) forms must be delivered with the containers. Any samples being split with another party must be properly labeled, contain a COC, and be packed and shipped according to DOT regulations.

A laboratory file is maintained listing sample kits prepared for clients. It contains the client name, address, form of delivery, preservative (if requested), sample bottle distribution, and analyses to be performed. Additionally, the date the kit is requested, sent and expected arrival date is included, along with any pertinent miscellaneous information.

9 STANDARD OPERATING PROCEDURES

GCAL employs standard procedures for all work performed. These standard procedures insure that work is completed in a professional and timely manner and that all contractual obligations are met.

Standard safety procedures are also part of GCAL Standard Operating Procedures. Confidentiality and security agreements on all work performed are strictly enforced.

Analytical SOPs must incorporate or reference the following topics:

- Identification of test method
- Applicable matrix or matrices
- Detection limit
- Scope of application
- Summary of test method
- Definitions
- Interferences
- Safety
- Equipment and supplies
- Reagents and standards
- Sample collection, preservation, storage, and handling
- Quality control
- Calibration
- Procedure
- Calculations
- Method performance
- Pollution prevention
- Data assessment and acceptance criteria
- Corrective action for out-of-control data
- Handling out-of-control data
- Waste management and
- References
- Tables, Diagrams, Flowcharts, and Validation Data

SOPs are reviewed annually and are the basis for internal method audits. If no changes are made to an SOP during review, an SOP review form is completed and appended to the last page of the original SOP kept on file. Refer to SOP QA-001 for document control procedures.

10 Sample Handling Guidelines

The following tables are guidelines to be used for sample container, quantity or volume, preservation and holding times. Specific information with regards to the Parameters listed in the table can be found in 40CFR Part 136 Tables IA, IB, IC, ID & IE and Table II., SW846 Table 4-1 and Table 3-1, SW846 Method 1311 Section 8.5,

Inorganic and Conventional Parameters

Parameters	Container	Recommended Weight (g) or Volume (mL) #	Preservative *	Holding Time **
Acidity	P,G	100	<6^0C	14 days
Alkalinity	P,G	100	<6^0C	14 days
Ammonia-N	P,G	500	<6^0C, H_2SO_4 to pH <2	28 days
Biochemical Oxygen Demand (BOD)	P,G	1000	<6^0C	48 hours
Bromide	P,G	200	None	28 days
Chemical Oxygen Demand (COD)	P,G	100	<6^0C H_2SO_4 to pH <2	28 days
Chloride	P,G	200	None	28 days
Chlorine, Residual	P,G	200	None	Immediately
Coliform, Fecal	P,G (sterile)	100	<6^0C, $Na_2S_2O_3$	6 hours
Color	P,G	100	<6^0C	48 hours
Cyanide	P,G	1000	<6^0C, ascorbic acid, NaOH to pH > 12	14 days
Ferrous Iron	P,G	100	2mHCl/100mL	Immediately
Flashpoint	P,G	100	None	Not specified
Fluoride	P	500	None	28 days
Hardness	P,G	100	HNO_3 to pH < 2	6 months
Nitrogen, Kjeldahl (TKN)	P,G	500	<6^0C, H_2SO_4 to pH < 2	28 day
Nitrate-N	P,G	100	<6^0C	48 hours
Nitrite-N	P,G	100	<6^0C	48 hours
Nitrate-Nitrite as N	P,G	200	<6^0C, H_2SO_4 to pH < 2	28 days
Oil and Grease	G	1000	<6^0C, H_2SO_4 or HCI to pH < 2	28 days
Phenols	P,G	1000	<6^0C, H_2SO_4 to pH < 2	28 days
Phosphorus, Total	P,G	200	<6^0C H_2SO_4 to pH < 2	28 days
Phosphorus, Ortho	P,G	200	<6^0C	48 hours
pH	P,G	100	None	Immediately
Radiochemistry Alpha, Beta,	P,G P,G	2000 100	HNO_3 to pH < 2 None	6 months 6 months

Parameters	Container	Recommended Weight (g) or Volume (mL) #	Preservative *	Holding Time **
Radium Tritium Radon, I-131	P,G	1000	HNO_3 to pH < 2	14 days
Reactivity	G	100g	<6^0C	Not Specified
Silica	P, PFTE, Quartz	100	<6^0C	28 days
Solids, Dissolved (TDS)	P,G	100	<6^0C	7 days
Solids, Suspended (TSS)	P,G	500	<6^0C	7 days
Solids, Volatile (TVS)	P,G	100	<6^0C	7 days
Solids, Total (TS)	P,G	100	<6^0C	7 days
Specific Conductance	P,G	100	<6^0C	28 days
Specific Gravity	P,G	100	<6^0C	28 days
Sulfate	P,G	200	<6^0C	28 days
Sulfide	P,G	500	<6^0C, Zn acetate, NaOH to pH > 9	7 days
Sulfite	P,G	200	None	Immediately
Surfactants (MBAS)	P,G	250	<6^0C	48 hours
Total Organic Carbon (TOC)	P,G	100	<6^0C, HCI to pH < 2	28 days
Total Organic Halogens (TOX)	G-TLC (amber)	100	<6^0C, H_2SO_4 to pH <2	28 days
Total Petroleum Hydrocarbon (TPH)	G-TLC	1000	<6^0C, H_2SO_4 or HCI to pH < 2	28 days
Turbidity	P,G	100	<6^0C	48 hours
Viscosity	P,G	500	None	Not Specified

Solid and waste samples: Quantity 1-100g as specified by the method,
* Preservative <6^0C.
** Holding time for solids and samples is not defined
NOTE: Organic Nitrogen = TKN – Ammonia-N

Metals

Parameters	Container	RecommendedWeight or Volume	Preservative	Holding Time
Aqueous				
Total	P,G	500 mL	HNO_3 to pH < 2	6 months
Dissolved	P,G	500 mL	Filter on site HNO_3 to pH < 2	6 months
Solid				
Total	P,G	100 g	<6^0C	6 months
<u>Hexavalent Chromium:</u>				
Aqueous	P,G	500 mL	<6^0C	24 hours
Solid	P,G	100g	<6^0C	30/7 days
<u>Mercury</u>:				
Aqueous				
Total	P,G	500 mL	HNO_3 to pH < 2	28 days
Dissolved	P,G	500 mL	Filter on site HNO_3 to pH < 2	28 days
Solid				
Total	P,G	100 g	<6^0C	28 days

NOTE: CrIII=Total Cr-Hexavalent Cr

Organic Parameters

Volatile Organics

Sample Matrix	Container	Minimum Quantity	Preservative	Holding Time
Concentrated Waste Samples	G-TLC or G-TLS	2 x 40 mL vials, 2-oz wide mouth	<6^0C	14 days
Aqueous Samples	G-TLS	2 x 40 mL vials	<6^0C, HCI to pH < 2, add $Na_2S_2O_3$ if residual chlorine present	14 days, 7 days if not acid preserved
Solid Samples	G-TLS or G-TLC	2-oz wide mouth and/or 3 Encores	<6^0C	14 days*

* Solid samples collected in EnCore™ samplers must be transferred to a soil sample vial within 48 hours of collection.

Semivolatile Organics, Pesticides/PCBs, Herbicides, PAH's And Petroleum Hydrocarbons

Sample Matrix	Container	Minimum Quantity	Preservative	Holding Time***
Concentrated Waste Sample	G-TLC (Amber)	1 Liter	None	14 days to extraction, 40 days after extraction
Aqueous Samples	G-TLC (Amber)	2 - 1 Liter	<6^0C	7 days to extraction, 40 days after extraction
Solid Samples	G-TLC	8 oz.	<6^0C	14 days to extraction, 40 days after extraction
Dioxins and Furans**	G-TLC(Amber)	2 - 1 Liter	<6^0C	30 days to extraction, 45 days after extraction

**Concentrated wastes and soil samples are collected in 2 oz. to 1 Liter amber glass jars with TLC as specified in the method.
***Samples for TX1005/1006, Petroleum Hydrocarbons analysis must be extracted within 14 days of collection and must be analyzed within 14 days after extraction

TCLP and SPLP Parameters

Parameters	Holding Time from Collection to TCLP Extraction (days)	Holding Time from TCLP Extraction to Preparative Extraction (days)	Holding Time from TCLP/Preparative Extraction to Analysis (days)	Total Time
Volatiles	14	NA	14	28
Semivolatiles	14	7	40	61
Mercury	28	NA	28	56
Metals	180	NA	180	360

Acronym Used in the Tables: (Teflon is a registered trademark of E.I. DuPont)
CLP: EPA Contract Laboratory Program
G-TLC: Glass with Teflon®-lined cap
NA: Not Applicable
G: Glass
G-TLS: Glass with Teflon®-lined septum
P: Polyethylene

10.1 Waste Collection and Storage

Samples are stored in the appropriate cooler for 60 days after receipt. After 60 days, samples are scanned out for disposal on the LIMS. The samples are then stored in the waste staging area until disposal into appropriate drums. Hazardous samples are returned to the client whenever possible to be disposed of with larger quantities of the sample material. Laboratory waste is segregated by laboratory personnel into waste streams, which have been established by the Safety and Regulatory Compliance Officer. The waste streams are determined by analysis of the waste and through process knowledge. All laboratory wastes are disposed of in the proper container. No waste is placed in regular trash containers or poured down the drain. Waste is stored in drums in satellite accumulation areas and then in the central accumulation facility. Waste disposal service is provided by approved vendors who will incinerate, landfill, treat, or reclaim the waste based on the characteristics.

10.2 Pollution Prevention

Environmental concerns, risks to employees, the public, and high disposal costs have increased the need and effort of the laboratory to minimize or prevent waste generation. The quantity of chemicals and standards purchased is based on expected usage during its shelf life and the disposal cost of the unused material. The volume of standards and reagents prepared in the laboratory reflect stability and anticipated usage. If possible, methods requiring the use of hazardous chemicals or that produce hazardous waste are replaced with an alternative method. Sample containers are selected based on the minimum volume that is necessary to perform a test, thereby reducing sample waste. Sample sizes are reduced in some cases, therefore reducing the quantities of extraction solvents and reagents.

11 SAFETY PROCEDURES

GCAL has a comprehensive safety program outlined for all employees. A safety manual is distributed to each employee followed by a training seminar to familiarize the employee with the safety procedures at GCAL.

11.1 Basic Safety Rules

1. All injuries are reported to a supervisor or member of management immediately.
2. All hazards are reported to a supervisor or member of management immediately.
3. Running and horseplay are not permitted in the laboratory.
4. Smoking is not permitted in the laboratory. Smoking is allowed in the designated area.
5. Laboratory glassware is not to be used for eating or drinking.
6. Laboratory reagents such as sucrose or sodium chloride shall not be used for food.

7. Eating on the premises is confined to designated areas. Eating is not allowed in the laboratory.
8. Proper personal protective equipment is always utilized. Safety glasses are to be worn in designated areas.
9. Contacts are not to be worn in designated laboratory areas.

11.2 Arrangement of Furniture and Equipment

Furniture is arranged for maximum use of available space while providing working conditions that are efficient and safe.

Aisles are kept at least 4 feet wide to provide for safe passage of personnel and equipment, and are kept free of obstructions.

Stepladders or footstools are supplied for reaching high objects and are kept out of the way when not in use.

Eyewash stations, safety showers and fire extinguishers are located centrally and care is taken to avoid blocking access to them.

11.3 Hoods and Ventilation

Adequate hood facilities are installed and used where toxic or flammable materials are used. Hoods with a sash provide physical protection from splash and greater control of fumes. Hood velocities are checked quarterly. Hoods are kept clean. Hoods are not to be used for storage.

11.4 Spills

Spilled materials are cleaned up promptly. All spills shall be handled as if corrosive or dangerous unless definitely known to be harmless. Spill Kits are located throughout the laboratory.

Corrosive or toxic materials are not placed in waste cans in the laboratory. When in doubt a supervisor is consulted.

Broken glass is swept up immediately and discarded so as to avoid any injury or cuts.

11.5 Emergency Equipment

Fire extinguishers are centrally located throughout the laboratory. The paths to these are kept free and clear at all times.

An extinguisher that has been used shall not be returned to its holder until it has been recharged and checked.

Any fire that appears to be too large to extinguish immediately is reported to the fire department at once. All fires, regardless of size are to be reported to a supervisor. Causes shall be determined and necessary steps to prevent a similar accident shall be taken.

Eyewashes are located in the laboratories for irrigation of the eyes if corrosive liquids or any other materials are splashed into the eyes.. Tubing attached to faucets in the sink shall also be used to wash the eyes if necessary.

Safety showers are centrally located throughout the laboratory and are used whenever corrosive materials are spilled on an analysts' skin or clothing.

All safety equipment is periodically checked to be sure everything is in working order and is easily accessible.

General first aid kits are located throughout the laboratory. These kits contain first aid products for the treatment of minor cuts and bruises, burns or abrasions, and personal discomfort.

11.6 Protective Equipment

Lab coats and aprons are supplied for all employees of GCAL. Protective clothing is available to prevent damage to clothing and persons.

Shoes must be worn at all times and must be closed-toe; high heels or sandals are not acceptable in lab areas.

Eye Protection is mandatory for all personnel working in the laboratory. Safety glasses or goggles shall be worn by analysts to protect the full eye area in designated areas. Placards identifying area that require the use of safety glasses are located throughout the laboratory. Guest visiting the laboratory will be required to wear safety glasses in specified areas.

Various types of gloves are provided for employees: Insulated gloves are provided for use when handling hot or cold items; Heavy rubber gloves are to be used when handling corrosive liquids or unknown substances; Lightweight disposable gloves are provided for use with toxic or irritating substances.

Air purifying respirators are available for use when working with organic vapors and/or acid fumes for qualified trained analysts. These respirators shall be worn whenever contact with irritating concentrations of these fumes is encountered.

11.7 Storage of Laboratory Materials

All chemicals, reagents and glassware are stored in such a manner that they are easily located and do not present a danger. Heavy items are kept near the floor.

Flammable solvents are stored in special cabinets or in solvent bunkers. Only quantities required for immediate use are stored in analytical areas.

Reagents are grouped to prevent danger from hazardous combinations. Acids and bases are stored separately. Oxidizing chemicals are stored away from acids and bases.

Compressed gases are stored away from heat and open flames. Compressed gas cylinders are secured to the wall or cabinet with chains or belts to prevent rolling or toppling. A special cart is used to transport replacement cylinders and empties.

11.8 Chemical And Sample Handling

If there are questions about proper chemical handling the MSDS (Material Safety Data Sheet) is used as reference.

- Samples are always treated as if they were hazardous chemicals.
- Rubber pipette bulbs are used for drawing samples or chemicals into pipettes.
- Procedures that produce flames or toxic vapors are performed under a hood.
- Chemicals are returned to their proper storage area after use.
- All prepared solutions are labeled with the name of the solution, ID number for the solution, concentration, lot number if applicable, date prepared, analyst preparing the solution, and expiration date.
- Acids are always poured into water when diluting.
- Large amounts of alkali are never added to water at one time.
- Glass-stopper containers are not used for storing alkaline solutions.
- Labels for Acid and Caustic solutions must include the concentrations and the lab assigned expiration date.

12 CONFIDENTIALITY

GCAL understands that it must retain in confidence all information obtained through the analysis of samples or the information disclosed to GCAL in order to adequately perform and interpret analytical data.

GCAL will maintain the secrecy and confidentiality of any proprietary information it receives or generates.

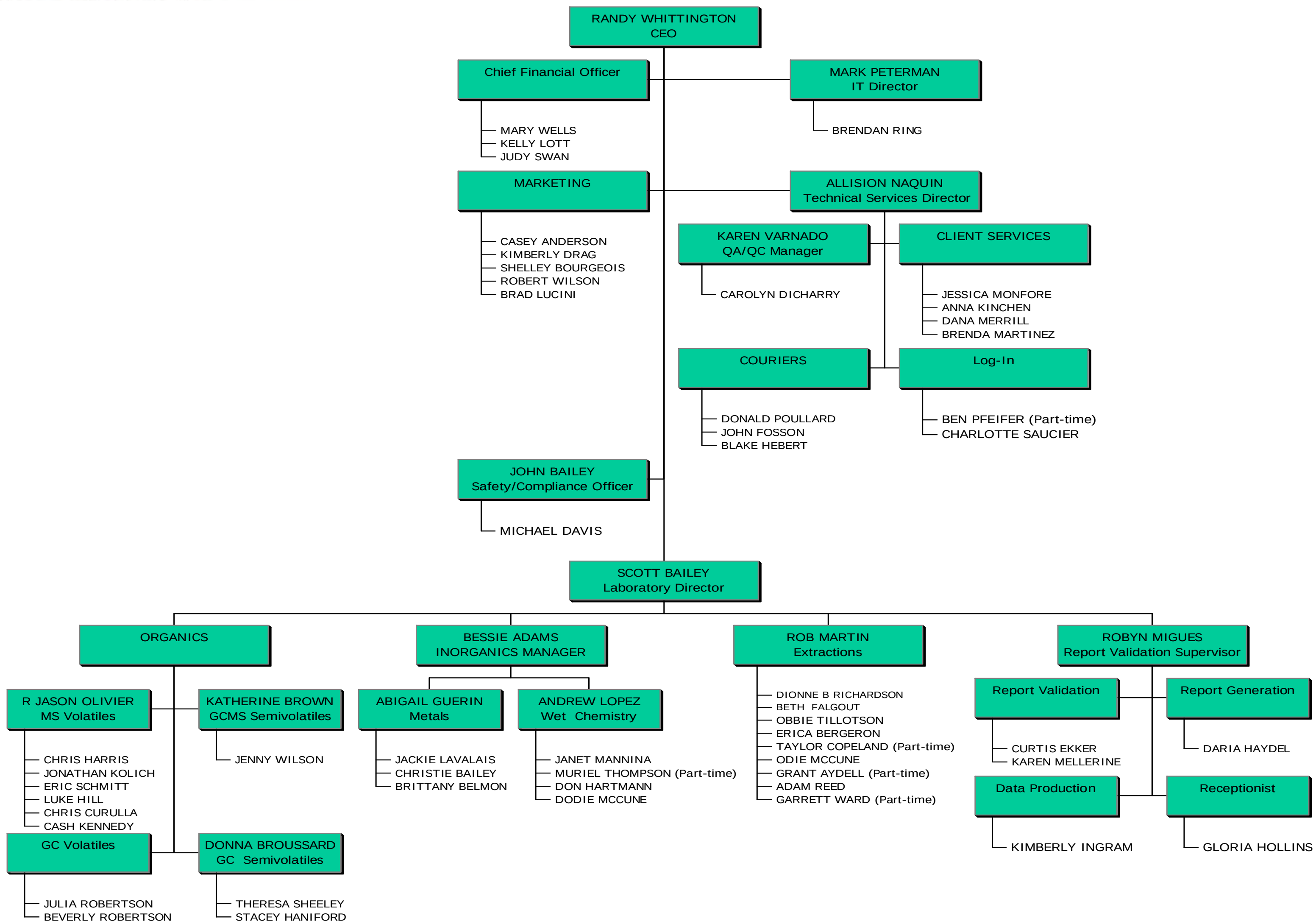
GCAL will not submit final analytical reports to anyone other than the contractor requesting the analytical services or consultation services. .

Entities that would like copies of reports released to other parties must provide GCAL with explicit written authorization. Reports will not be release to anyone other than the contractor without GCAL having first received authorization.

Appendix A

GULF COAST ANALYTICAL LABORATORIES, INC

ORGANIZATIONAL CHART



4/2/2012

Appendix B

RANDY K. WHITTINGTON

Current Position: **CEO, Gulf Coast Analytical Laboratories, Baton Rouge, LA, October 2009 - present**

Responsible for financial and marketing functions. Responsible for long range planning and structuring of future business operations..

Previous Experience: **Technical Services Manager, Gulf Coast Analytical Laboratories, Baton Rouge, LA, January 1997 – April 2007**

Responsible for the management and supervision of Sample Management, Project Management, and Report Generation. Duties include implementing systems for increased productivity in all three sections. Also coordinates communication among these departments and other areas of the laboratory and marketing.

Technical Services Manager, ITS-Environmental Laboratories, Baton Rouge, LA, October 1996 - January 1997

Responsible for the management and supervision of Sample Management, Client Services, and Report Generation. Duties include implementing systems for increased productivity in all three sections. Also coordinates communication among these departments and other areas of the laboratory and marketing.

Project Manager and Data Validation Manager, Terra Consulting Group, Baton Rouge, LA, 1993 - 1996

Performed organic data validation for CLP and RCRA data packages for pesticides, PCBs, volatile and semi-volatile analytical fractions. Responsible for the design and implementation of the analytical aspects needed to generate legally defensible data for a Remedial Feasibility Investigation (RFI) at various large chemical plants. Ensured data validation issues were addressed in the day-to-day operations of the investigation.

Gas Chromatography Supervisor, West-Paine Laboratories, Baton Rouge, LA, 1991-1993

Directly responsible for the supervision of the organics laboratory in Randy environmental and hazardous waste matrices following current SW-846, 500 and 600 series methodologies. Responsibilities include coordinating and managing of QA/QC for all Gas Chromatography data from sample log-in, extraction, analysis, review and preparation of computerized reports.

Gas Chromatography Laboratory Manager, ETC/Toxicon, Baton Rouge, LA, 1987-1991

Supervised the Gas Chromatography laboratory in the analysis of Organochlorine and Organophosphorus Pesticides, PCBs, Herbicides, PNAs, VOA and Semi-VOAs; supervised all aspects of the GC laboratory including analysis, data interpretation, report preparation, instrument maintenance, method development, and problem solving. In 1990 temporarily relocated to Edison, New Jersey to restructure the Gas Chromatography division while also implementing USEPA CLP and Finnigan QA Formaster; maintained efficiency of twenty-two various Gas Chromatographs.

Education:

BS, Environmental Engineering , Columbia Southern University

Inchcape Managerial Training Skills Workshop - 1993

Finnigan QA Formaster Training

Restek Chromatography Class

Bank One Managing and Financing Independent Business - 16 Hours - October 1998

SCOTT A. BAILEY

Current Position: **Laboratory Director, Gulf Coast Analytical Laboratories, Baton Rouge, LA January 2011 - Present**

Responsible for coordinating the overall activities of the analytical laboratories on a daily basis and providing long-term direction. Responsibilities include monitoring the scheduling of analytical testing and releasing testing data and results.

Previous Experience: **Technical Advisor, Gulf Coast Analytical Laboratories, Baton Rouge, LA June 2007 – December 2010**

Assisted laboratory management with training needs, method development, and data validation.

Operations Manager, Gulf Coast Analytical Laboratories, Baton Rouge, LA January 1997 – May 2007

Responsible for coordinating the overall activities of the analytical laboratories on a daily basis and providing long-term direction. Responsibilities include monitoring the scheduling of analytical testing and releasing testing data and results.

Operations Manager, ITS-Environmental Laboratories, Baton Rouge, LA September 1995 - January 1997

Responsible for coordinating the overall activities of the analytical laboratories on a daily basis and providing long-term direction. Responsibilities include monitoring the scheduling of analytical testing and releasing testing data and results.

Organics Manager, ITS – Environmental Laboratories, Baton Rouge, LA, October1993 - September 1995

Responsible for the management of the GC, GCMS, and the extraction departments of the laboratory. Duties also included supervision of the report generation department.

Division Manager, National Environmental Testing, Baton Rouge, LA March 1992 - October 1993

Directed the functional areas of marketing, finance, chemistry, and administration for the Baton Rouge facility. Additional duties included contract administration, scheduling, and client consultation.

Operation Manager, Environmental Testing & Certification Corporation, Baton Rouge, LA , December 1989 - January 1992

Directed the functional areas of marketing, finance, chemistry, and administration for the Baton Rouge facility. Additional duties included contract administration, scheduling, and client consultation.

Analyst, ETC, Baton Rouge, LA, December 1983 - December 1989

Education:

BS, Environmental Health, Louisiana State University, Baton Rouge, LA, December 1991

ITS Managerial Training Skills Workshop, 1994

ITS - Environmental Laboratories, Baton Rouge, Manager and Supervisor Training Retreat - June 1996

UCLA ITS Executive Development Program - August 1996

ALLISON M. NAQUIN, Ph.D.

Current Position: **Technical Services Director, GCAL Inc, Baton Rouge, LA Jan 2011**

Responsible for managing all technical aspects of the laboratory facility. Responsible for ensuring the laboratory produces quality data, while generating and implementing strategies to improve service levels, quality and efficiency throughout the organization.

Previous Experience:

Laboratory Manager, GCAL Inc, Baton Rouge, LA, Jan 2010 – Jan 2011

Responsible for coordinating the overall activities of the analytical laboratories on a daily basis and providing long-term direction. Responsibilities include monitoring the scheduling of analytical testing and releasing testing data and results. Continue General Manager duties as described below.

General Manager, QA/QC Manager, GCAL, Inc., Baton Rouge, LA, August 2007 – Jan 2011

Responsible for all operations within the facility including laboratory and administrative policies and procedures.

QA/QC Manager, GCAL Inc., Baton Rouge, LA, April 2005 – August 2007

Responsible for implementing and monitoring the laboratory Quality Assurance Program Plan, conducting internal audits, investigating problem areas, control-chart generation, establishing data-quality criteria, verifying corrective actions are being taken when necessary, directing participation in accreditation programs, and monitoring performance evaluation studies. Additional duties include administering the ethics training/data integrity program and providing reports concerning QA matters to management.

Laboratory Auditor, GCAL Inc., Baton Rouge, LA, February 2005 – April 2005

Support QA/QC functions and perform internal audits. Responsibilities include performing internal audits of lab and writing audit reports. Assist in writing standard operating procedures.

Environmental Scientist Supervisor, Louisiana DEQ, Baton Rouge, LA, December 2004 – February 2005

Served as the Technical Advisor for the laboratory to the Assistant Secretary of the Office of Environmental Assessment. Responsibilities include draft/review and approval of Quality System documents; advise laboratory on technical and quality issues to obtain NELAP accreditation, and audit laboratory activities to NELAC standards. Continue assistance to Lab Accreditation Program.

Environmental Scientist III, Louisiana DEQ, Lab Accreditation Program, Baton Rouge, LA, April 2002 – December 2004

Assess commercial environmental and industrial laboratories to NELAC/ISO standards, and assess quality documents. Responsibilities also include serving as organic specialist to accreditation group, review data packages, assist in training seminars to environmental community, and assists Executive Staff with technical issues.

Environmental Scientist I-II, Louisiana DEQ, Laboratory Services Division, Baton Rouge, LA, February 2001 – April 2002

Responsibilities include analysis of volatile samples by GC/MS, interpretation and reporting data, preparation of data packages, and draft standard operating procedures. Cross-trained on semi-volatile analysis by GC/MS.

Research Assistant, Louisiana State University, Chemistry Department Baton Rouge, LA, August 1998 – December 2000

Responsibilities include directing daily activities of research lab, conduct environmental research, maintain and repair laboratory equipment, and mentor undergraduate students. Also, prepared and delivered seminars on personnel research and related literature, and was liaison between LSU and Southern University for research project.

Teaching Assistant, Louisiana State University, Chemistry Department Baton Rouge, LA, January 1995 – August 1998

Responsibilities include instructor for general chemistry laboratory, tutor undergraduate students, and provides class reviews and exam proctoring for professors.

Independent Contractor, Baton Rouge, LA, September 1998 – November 1998

Performed metals digestion and ICP/MS analysis of environmental samples from an EPA clean-up site. Issued reports to Dr. James Wharton of LSU Chemistry Department.

Adjunct Chemistry Instructor, Louisiana State University, Chemistry Department, Baton Rouge, LA, August 1994 – December 1994

Responsibilities include instructor for general chemistry laboratory, provides instruction in class materials, and administers and grades class-work and exams.

Education

Doctor of Philosophy, Chemistry, Louisiana State University, Baton Rouge, LA, May 2001

BS Chemistry, Louisiana State University, Baton Rouge, LA August 1994

Accreditation Process, Laboratory Ethics, How to Write Quality Documents Training Course, Analytical Excellence, April 2004

Assessments for ISO/IEC 17025 & NELAC (ASI Course 300), Advanced Systems, Inc., July 2003

Data Assessment Training, Analytical Excellence, Inc., May 2003

QA/QC Workshop, Advanced Systems, Inc., May 2003

Calibration and Manual Integration, Analytical Excellence, Inc., May 2003

HAZWOPER 40-hour Training Course, July 2002 and yearly refreshers August 2003 and August 2004

Data Integrity Seminar – Ethics Training, Analytical Excellence, Inc., March 2002 and yearly refresher

Environmental GC/MS Instrument and ChemStation Operation, Agilent Technologies, October 2001

Comprehensive Public Training Program

SHELLEY BOURGEOIS

Current Position:

Client Services Manager, Gulf Coast Analytical Laboratories, Baton Rouge, LA, April 2007 – present

Responsible for the management and supervision of Sample Management and Project Management. Duties include implementing systems for increased productivity and coordinating communication among these departments and other areas of the laboratory.

Previous Experience:

Project Chemist, Conestoga-Rovers & Associates, Baton Rouge, LA, May 2004 – April 2007

Responsible for contracting analytical laboratory services and for QA/QC verification of data. Performed data validations and ensured data validation issues were addressed in the day-to-day operations of the investigation.

Inorganics Manager, Gulf Coast Analytical Laboratories, Baton Rouge, LA, May 1998 – May 2004

Responsible for the management and supervision of the Metals Laboratory. Duties include the management and training of personnel, scheduling of sample workloads, supervision of metals sample preparation, analysis of samples by various analytical instrumentation, coordination of laboratory QA/QC projects, and maintenance of procedures to QA/QC guidelines. In addition, responsibilities include comprehensive data review and validation for the laboratory as well as the coordination of higher level QA data packages.

Metals Analyst, Gulf Coast Analytical Laboratories, Baton Rouge, LA, December 1997 – May 1998

Responsible for analysis of samples by various instruments including GFAA, Flame AA, ICP and the mercury analyzer. Additional responsibilities included data reduction and posting in the LIMS.

Head Technician, American Radiation Services, Baton Rouge, LA, November 1996 - December 1997

Responsible for coordinating sample analysis and field services. Supervised sample receipt, preparation, analysis, and report generation.

Analyst, ITS Environmental Laboratories, Baton Rouge, LA, July 1996 - November 1996

Education:

BS/Microbiology - Louisiana State University, Baton Rouge, LA, December 1995

Perkin Elmer Atomic Spectroscopy Workshop, Baton Rouge, LA, April 1998

Perkin Elmer Optima Instrument Series ICP training, Atlanta, GA, June 1998

ROBYN B. MIGUES

Current Position: **Technical Director, Gulf Coast Analytical Laboratories Baton Rouge, LA, April 2005 – Present**

Responsible for report validation and review. Responsible for review of Quality Assurance Project Plans on incoming projects and implementation of such plans throughout the laboratory. Assists the lab in method implementation and development. Additional duties include advising the laboratory on reference methods and improving method performance.

Previous Experience: **QA/QC Manager, Gulf Coast Analytical Laboratories Baton Rouge, LA, January 1997 – April 2005**

Responsible for implementing and monitoring the laboratory Quality Assurance Program Plan, conducting internal audits, reviewing reports, investigating problem areas, control-chart generation, establishing data-quality criteria, verifying corrective actions are being taken when necessary, and monitoring performance evaluation studies. Additional duties include providing reports concerning QA matters to management.

QA/QC Manager, ITS- Environmental Laboratories, Baton Rouge, LA October 1994 - January 1997

Responsible for implementing and monitoring the laboratory Quality Assurance Program Plan, conducting internal audits, reviewing reports, investigating problem areas, control-chart generation, establishing data-quality criteria, verifying corrective actions are being taken when necessary, and monitoring performance evaluation studies. Additional duties include providing reports concerning QA matters to management.

General Chemistry Supervisor, ITS- Environmental Laboratories, Baton Rouge, LA, June 1994 - October 1994

Responsibility includes the management and training of personnel conducting inorganic analysis using EPA methodologies. Duties include data validation, QC review, instrument maintenance and method set up.

Metals Supervisor, ITS –Environmental Laboratories, Baton Rouge, LA, October 1993 - June 1994

Responsible for the management and supervision of the Metals section which includes supervision of metals sample preparation, supervision and training of analysts, scheduling sample workload, analysis of samples by various analytical instrumentation and reviewing and validating all data.

Research Associate, Louisiana State University, Agronomy Department, Baton Rouge, LA, September 1990 - March 1993

Prepared and analyzed samples by ICP, maintained ICP and other laboratory equipment, assisted associate Professor of soil and environmental chemistry with laboratory courses and research projects and supervised student workers. Computer experience includes Quattro Pro and Wordperfect.

Previous Experience:

Spectroscopy and Water Departments Supervisor, James Laboratories, Lafayette, LA, February 1987 - September 1990
Laboratory Technician

Prepared and analyzed samples by ICP, Flame Atomic Absorption & Emission, Mercury Hydride System and Graphite Furnace. Performed quality control coordination, trained laboratory technicians, maintained equipment . Prepared and analyzed various sample types.

Education:

BS Geology, University of Southwestern Louisiana, Lafayette, LA, May 1985.

Member - American Society for Quality Control

Perkin Elmer Spectroscopy training course - 1987

Basic Statistics - Pittsburgh Conference Continuing Education Program - March 1995

Quality Management/Quality Assurance in Industry and in the Laboratory - ACS Short Course - March 1995

Inchcape Managerial Training Skills Workshop - 1994

Inchcape Testing Services - Environmental Laboratories, Baton Rouge, Manager and Supervisor Training Retreat - June 1996

Executrain Microsoft Excel 5.0 Beginning For Windows - July, 1996

ERTCO - Thermometer Calibration per ISO - October 1997

Assuring Ethical Practices in The Environmental Laboratory, A Training Short Course – Analytical Excellence – October 27, 2000

Member - LADEQ Laboratory Accreditation Task Force

Karen S. Rodrigue-Varnado

Current Position: **Quality Assurance Manager, GCAL Inc., Baton Rouge, LA May 2011**
Responsible implementing and monitoring the laboratory Quality Assurance Program, conducting internal audits, investigating problem areas, establish data quality criteria, verifying corrective actions are getting taken when necessary, directing participation in state and federal accreditation programs, monitoring training records, and monitoring proficiency test studies. Additional duties include administering the ethics training/data integrity program and providing reports concerning QA maters to management.

Previous Experience:

Quality Assurance Manager, Sherry Laboratories, Lafayette, LA February 2009 – May 2011
Responsible implementing and monitoring the laboratory Quality Assurance Program for the environmental and biomonitoring laboratory, air laboratory in Garland TX and the natural gas laboratory in Scott, LA.. Responsible for conducting internal audits, investigating problem areas, establish data quality criteria, verifying corrective actions are getting taken when necessary, directing participation in state and federal accreditation programs, monitoring training records, and monitoring proficiency test studies. Additional duties include administering the ethics training/data integrity program, providing reports concerning QA maters to management. Responsible for maintaining certification of all Sherry Laboratories - Southern Region.

Quality Assurance Manager, Analytical Products Group, Belpre, OH February 2008 – December 2008.
Responsible implementing and monitoring the laboratory Quality Assurance Program for an approved Proficiency Test Provider Responsible for maintaining facility ISO 17025, ISO 17011 and Guide 34 and Guide 43 certification as well as A2LA certification. Responsible for conducting internal audits, investigating problem areas, establish data quality criteria, verifying corrective actions are getting taken when necessary, directing participation in state and federal accreditation programs, monitoring training records, and monitoring proficiency test studies. Additional duties include administering the ethics training/data integrity program and providing reports concerning QA maters to management.

Environmental Scientist Supervisor, Louisiana Department of Environmental Quality, Lab Accreditation Program
October 2001 – February 2008

Responsible for the operation of the laboratory accreditation program with a budget of $9 million. Managed 7 state assessors and 8 contract assessors. Responsible for certifying of 250 laboratories nationally. Louisiana State representative to the National Environmental Laboratory Accreditation Conference (NELAC). Voting member for the State of Louisiana at NELAP. Member of the Board of Directors for NELAP and TNI. Member of Chapter 5, Accreditation, and Proficiency Test Committees of NELAC and TNI.

Environmental Scientist 3, Louisiana Department of Environmental Quality
October 1989 – October 2001
Drafted regulations for the Louisiana Environmental Laboratory Accreditation Program**.** Participated in developing the Laboratory Accreditation Program**.** Responsible for inspecting major and minor facilities for the Department of Environmental Quality and reporting issues to the DEQ and EPA. Responsible for managing support service laboratory contracts for the Department totaling over $5 million. Drafted environmental compliance orders and penalties for DEQ. Acted and Quality Assurance Officer for the Ground Water Protection Division. Participated in drafting the DEQ's strategic plan and the Quality Assurance Manual.

Environmental Scientist 3, Louisiana Department of Health and Hospitals, Office of Public Health, Laboratory Services
April 1988 – October 1989
Performed bacteriological testing on dairy products, potable and non-potable water, animal specimens, blood and various cultures.

TEXACO, Inc.
Products Control Laboratory, March 1981 – October 1982
Performed open-cup flash testing, Pensky-Marten closed cup testing, ash testing, various titrations, viscosity, leco carbon, % moisture testing on all finished products from the oil refinery and crude oil.

Education

B.S in Biology, Lamar University, Beaumont, TX
Minor in Chemistry and Secondary Education

Accreditation Process, Laboratory Ethics, How to Write Quality Documents Training course, Analytical Excellence, Inc. April 2004

Assessments for ISO/IEC 17025 & NELAC (ANSI Course 300), Advanced Systems, Inc. July 2003

Data Assessment Training, Analytical Excellence, Inc., May 2003

QA/QC Workshop, Advanced Systems, Inc. May 2003

Calibration and Manual Integration, Analytical Excellence, Inc., May 2003

DQO/DQA, USEPA

Quality Assurance Quality Control, USEPA

Assessor Training, USEPA June 1997

Hazwoper 40 Hour Training Course, 1990. 8 hour refresher training annually thereafter.

Data Integrity Seminar – Ethics Training, Analytical Excellence, 1998 and annual refresher.

NPDES Inspector Training, USEPA, 1990

Comprehensive Public Training Program

Various computer courses.

Appendix C

GCAL Equipment List

ORGANICS	Location	Date Received	Date in Service	Condition	MAKE/MODEL	SERIAL NUMBER
GCMSSV 4	MSSV Lab	September-05	September-08	new	AGILENT 5975	US52430653
	MSSV Lab	September-05	September-08	new	AGILENT 6890N	CN10532052
GCMSSV 5	MSSV Lab	November-05	November-05	new	AGILENT 5975	US53931245
	MSSV Lab	November-05	November-05	new	AGILENT 6890N	CN10539069
GCMSSV 6	MSSV Lab	July-07	July-07	new	Agilent 7890	CN10717068
	MSSV Lab	July-07	July-07	new	Agilent 5975C	US71235850
GCMSV 0	MSV lab	September-01	September-01	new	HP 5890 SERIES II	3336A58851
	MSV lab	September-01	September-01	new	HP 5972	3501A02325
	MSV lab	September-01	September-01	new	Teledyne/Tekmar-XPT	US05279001
	MSV lab	September-01	September-01	new	T/D Solatek 72	USO2294002 (GCAL# 0337)
GCMSV5	MSV lab	October-03	October-03	new	HP 5890 SERIES II	3310A48460
	MSV lab	October-03	October-03	new	HP 5971	3307A00395
	MSV lab	October-03	October-03	new	Tekmar LCS 2000	90211015/93154002/9115009
GCMSV 8	MSV Lab	October-01	October-01	new	AGILENT 5973	US10441235
	MSV Lab	October-01	October-01	new	AGILENT 6890N	US10134037
	MSV Lab	October-01	October-01	new	Teledyne/Tekmar-XPT	US03240004
	MSV Lab	October-01	October-01	new	T/D Solatek 72	US05283001
GCMSV 9	MSV lab	April-07	April-07	new	AGILENT 5979B	US63234781
	MSV lab	April-07	April-07	new	AGILENT 6890N	CN10647134
	MSV lab	April-07	April-07	new	Teledyne/Tekmar-XPT	US06296004
	MSV lab	April-07	April-07	new	T/D Solatek 72	US07022004
GCMSV 11	MSV Lab	April-04	April-08	new	AGILENT 5973	US33220204
	MSV Lab	April-04	April-08	new	AGILENT 6890N	CN10407013
	MSV Lab	July-07	July-07	new	Teledyne/Tekmar-XPT	US03140007
	MSV Lab	July-07	July-07	new	T/D Solatek 72	US02098018
GCMSV 12	MSV Lab	June-10	June-10	new	AGILENT 5973	US10441235
	MSV Lab	June-10	June-10	new	AGILENT 7890A	CN10211053
	MSV Lab	June-10	June-10	new	Teledyne/Tekmar-XPT	US10160001
	MSV Lab	June-10	June-10	new	T/D Solatek 72	US05283001
FUME HOOD	MSV Lab	January-97	January-97	new	LABCONCO (#20) GCMSV	N/A
FUME HOOD	MSSV Lab	January-97	January-97	new	LABCONCO (#19)	N/A
COOLER	MSV lab	January-97	January-97	new	TRUE (#22)	1330620
COOLER	MSV lab	January-97	January-97	new	TRUE/GDM-45 (#30)	1-3681854
REFRIG/FREEZER	MSV lab	January-97	January-97	new	KENMORE/2538684012	0983108619
REFRIG/FREEZER	MSV lab	January-97	January-97	new	SEARS (V0A 2)	983108619
FREEZER#12	MSV lab	January-97	January-97	new	FRIGIDAIRE, MODEL #MFU17F3GW6 (#12) C	WB02927861
REFRIGERATOR (#41)	MSV lab	February-11	February-11	new	FRIDGIDAIRE (#41)	BU1210823890132
FREEZER (#45)	MSV lab	May-11	May-11	new	Holiday LCM050LC	BFGEW0E1J00BRABF3131
BALANCE	MSV lab	January-97	January-97	new	METTLER AE200	L65273
BALANCE	MSV lab	July-11	July-11	new	METTLER XS2002S	B048091720
GCSV 12	GCSV Lab	November-03	November-03	new	AGILENT TECH 6980N	US10338067
GCSV 14	GCSV Lab	January-04	January-04	new	AGILENT TECH 6980N	US10342128
GCSV 15	GCSV Lab	April-04	April-04	new	AGILENT TECH 6980N	CN10413018

GCAL Equipment List

GCSV 16	GCSV Lab	August-05	August-05	new	AGILENT TECH 6980N	CN10525006
GCSV 17	GCSV Lab	September-05	September-05	new	AGILENT TECH 6980N	CN10529074
GCSV 18	GCSV Lab	September-05	September-05	new	AGILENT TECH 6980N	CN10528084
GCSV 19	GCSV Lab	September-05	September-05	new	AGILENT TECH 6980N	CN10534099
GCSV 20	GCSV Lab	October-05	October-05	new	AGILENT TECH 6980N	CN10534109
GCSV 21	GCSV Lab	December-05	December-05	new	AGILENT TECH 6980N	CN10538039
FUME HOOD	GCSV Lab	January-97	January-97	new	LABCONCO(#33)	301116
GCV 5	GCV Lab	February-08	February-08	new	AGILENT 6890 SERIES	US00026701
GCV 6	GCV Lab	November-05	November-05	new	AGILENT 6890N SERIES	CN10538061
GCV 7	GCV Lab	April-07	April-07	new	AGILENT 6890N SERIES	CN10545063
GCV 8	GCV Lab	April-08	April-08	new	AGILENT 6890N SERIES	CN10636089
GCV9	GCV Lab	March-05	June-10	new	AGILENT 6890N	CN10452003
PURGE/TRAP INSTRUMENT 5	GCV Lab	February-08	February-08	new	TELEDYNE TEKMAR / 14-8900-00T	US05257002
PURGE/TRAP INSTRUMENT 6	GCV Lab	November-05	November-05	new	TEKMAR	BETA 005
PURGE/TRAP INSTRUMENT 7	GCV Lab	April-07	April-07	new	TELEDYNE TEKMAR XPT / 14-8900O0T	US0527002
PURGE/TRAP INSTRUMENT 9	GCV Lab	March-05	June-10	new	TELEDYNE TEKMAR XPT	US0507010
AUTOSAMPLER INSTRUMENT 5	GCV Lab	February-08	February-08	new	TELEDYNE TEKMAR SOLATEK 72	US02277005
AUTOSAMPLER INSTRUMENT 6	GCV Lab	November-05	November-05	new	TELEDYNE TEKMAR AQUATek 70	US05355004
AUTOSAMPLER INSTRUMENT 7	GCV Lab	April-07	April-07	new	TELEDYNE TEKMAR AQUATek 70	US05347003
AUTOSAMPLER INSTRUMENT 9	GCV Lab	March-05	June-10	new	TELEDYNE TEKMAR SOLATEK 72	US0324004
Digital Vortex Meter	GCV Lab	November-08	November-08	new	N/A	080801081
BALANCE	GCSV Lab	August-11	August-11	new	SARTORIUS AY612	26655670
REFRIGERATOR (#43)	GCV Lab	March-11	March-11	new	Frigidaire (#43)	KA03300793
REFRIGERATOR	GCSV Lab	January-97	January-97	new	MASTERBILT (#18)	254034
FREEZER	GCSV Lab	January-97	January-97	new	Frigidaire (#34)	WB44328710
REFRIG/FREEZER	GCSV Lab	January-97	January-97	new	SEARS (#11)	BA01000875
REFRIG/FREEZER	GCSV Lab	January-97	January-97	new	KENMORE (#14)	BA04391055
REFRIG/FREEZER	GCSV Lab	January-97	January-97	new	KENMORE (#15)	BA04391057
REFRIG/FREEZER	GCSV Lab	January-97	January-97	new	KENMORE (#17)	BA03100524
FREEZER	GCSV Lab	January-97	January-97	new	Whirlpool (#37)	EWW3489616
FREEZER	GCSV Lab	January-97	January-97	new	Frigidaire (#26)	WB83724994
HPLC	**Location**	**Date Received**	**Date in Service**	**Condition**	**MAKE/MODEL**	**SERIAL NUMBER**
COLUMN HEATER	MSSV Lab	December-06	December-06	new	EPPENDORF TC-45	N/A
HPLC - 2	MSSV Lab	December-06	December-06	new	AGILENT 1200 SERIES - MWD	DE60555127
	MSSV Lab	December-06	December-06	new	AGILENT 1200 SERIES - FLD	DE60555722
	MSSV Lab	December-06	December-06	new	AGILENT 1200 SERIES - TCC	DE63060177
	MSSV Lab	December-06	December-06	new	AGILENT 1200 SERIES - QUANT PUMP	DE60556714
	MSSV Lab	December-06	December-06	new	AGILENT 1200 SERIES - ALS	DE60557762
	MSSV Lab	December-06	December-06	new	AGILENT 1200 SERIES - DEGASSER	JP62354304
METALS	**Location**	**Date Received**	**Date in Service**	**Condition**	**MAKE/MODEL**	**SERIAL NUMBER**
ICP/MS	Metals Lab	September-10		new	Agilent 7700/7500 Series	JP10280491
ICP/MS Autosampler	Metals Lab	September-10		new	Agilent ASX-500	US071080A520
ICP	Metals Lab	September-05	September-05	new	PERKIN-ELMER OPTIMA 4300DV	077N0050202
AUTOSAMPLER	Metals Lab	September-05	September-05	new	PERKIN-ELMER AS93 Plus	N/A

GCAL Equipment List

ICP	Metals Lab	May-00	May-00	new	PERKIN-ELMER 5300DV	077N5090602
GFAA 2	Metals Lab	January-09	January-09	used	PERKIN-ELMER 800	8411
GFAA Autosampler	Metals Lab	January-09	January-09	used	PERKIN-ELMER AS800	1852
GFAA Chiller	Metals Lab	January-09	January-09	used	N/A	N/A
HG ANALYZER	Metals Lab	January-97	January-97	new	PERKIN ELMER/FIMS 400	4515
CHILLER	Metals Lab	January-97	January-97	new	Polyscience	G51284
FUME HOOD--FLOW SCIENCES	Metals Lab	January-97	January-97	new	FS3100BKFVA	11-j-07-04
FUME HOOD	Metals Lab	January-97	January-97	new	FS3100BKFVA	11-j-07-15
Digital Conductivity Meter	Metals Lab	May-11	May-11	new	Fisher Scientific/09-327	111438708
METALS PREP	**Location**	**Date Received**	**Date in Service**	**Condition**	**MAKE/MODEL**	**SERIAL NUMBER**
MICROWAVE	Metals Prep Lab	January-97	January-97	new	CEM MARS5	DS-6208
DIGESTION BLOCKS (4)	Metals Prep Lab	January-97	January-97	new	CPI MOD BLOCK	N/A
FUME HOOD -FLOW SCIENCES (2)	Metals Prep Lab	January-97	January-97	new	FS3100BKDVA / FS3100BKGVA	05-N-03-02 / 08-M-13-02
BALANCE	Metals Prep Lab	July-07	July-07	new	Mettler Toledo XS 104	1128260845
EXTRACTIONS	**Location**	**Date Received**	**Date in Service**	**Condition**	**MAKE/MODEL**	**SERIAL NUMBER**
FUME HOODS (18)	EXT Area	January-97	January-97	new	N/A	N/A
GLASS WASHER	EXT Area	January-97	January-97	new	AMSCO 400	36911195001
SHAKER (4)	EXT Area	January-97	January-97	new	GLAS-COL 099A	N/A
MILLIPORE(2)	EXT Area	January-97	January-97	new	N/A	N/A
VACUUM PUMP	EXT Area	May-08	May-08	new	Edwards	76434563
GPC (1)	EXT Area	January-97	January-97	new	ABC AP-100	9161SI/AS007-9114-9114
CENTRIFUGE	EXT Area	January-97	January-97	new	IEC HN-SII	N/A
OVEN	EXT Area	January-97	January-97	new	FISHER ISOTEMP 655G	11000184
TCLP/ZHE ROTATOR	EXT Area	January-97	January-97	new	ASSOCIATED DESIGN	NA 05101808
ZHE EXTRACTORS	EXT Area	January-97	January-97	new	ENVIRONMENTAL EXPRESS	NA 05081684
SONICATOR (6)	EXT Area	January-97	January-97	new	FISHER SCIENTIFIC	BBW052140/BBW05101848/BBW025101849/BBW05101850
INCUBATOR SHAKER	EXT Area	January-97	January-97	new	NEW BRUNSWICK SCIENTIFIC/CLASSIC SEF	100524881
BALANCE	EXT Area	January-97	January-97	new	METTLER PM 3000	M33557
BALANCE	EXT Area	January-97	January-97	new	METTLER PG 3001 S	1117331005
BALANCE	EXT Area	January-97	January-97	new	AND FX-300	5015502
BALANCE	EXT Area	January-97	January-97	new	OHAUS SCOUT PRO SP2001	7124330243
BALANCE	EXT Area	January-97	January-97	new	OHAUS SCOUT PRO SP402	7124280031
BALANCE	EXT Area	January-97	January-97	new	OHAUS SCOUT PRO SPE4001	7123450167
BALANCE	EXT Area	January-97	January-97	new	OHAUS SCOUT PRO SP2001	7124371673
PH METER	EXT Area	January-97	January-97	new	ORION SA520	QT20A
PH METER	EXT Area	January-97	January-97	new	THERMO ORION 720A	074216
PH METER	EXT Area	January-97	January-97	new	ORION 720A+	085153
PH METER	EXT Area	January-97	January-97	new	ORION 720A+	089622
PH PROBE 01/ATC PROBE	EXT Area	January-97	January-97	new	ORION SURE-FLOW ROSS 8172BNWP	LYI-16730
PH PROBE 03/ATC PROBE	EXT Area	January-97	January-97	new	ORION SURE-FLOW ROSS 8172BNWP	MX3-10451
PH ELECTRODE (03)	EXT Area	January-97		new	ORION SURE FLOW	MP3-10011
COOLER	EXT Area	January-97	January-97	new	TRUE (#5)	1334961
REFRIG/FREEZER	EXT Area	January-97	January-97	new	WHITE WESTINGHOUSE (#8)	LA10903763
REFRIG/FREEZER	EXT Area	January-97	January-97	new	WHITE WESTINGHOUSE (#9)	BA04391056

GCAL Equipment List

REFRIG/FREEZER	EXT Area	January-97	January-97	new	Frigadaire (R#34)	BA61019273
FREEZER	EXT Area	January-97	January-97	new	WHITE WESTINGHOUSE (#23)	WB40802629
ULTRASONIC CLEANER	EXT Area	January-97	January-97	new	FISHER SCIENTIFIC/FS30	RTB040265340
MUFFLE FURNACE	EXT Area	January-97	January-97	new	FISHER SCIENTIFIC/ISOTEMP 550 SERIES M(	410N0074
STANDARD TEST SIEVE	EXT Area	January-97	January-97	new	WS TYLER/MODEL #RX-812	24372
PYROMETER	EXT Area	January-09	January-09	new	PM20700	SN 8502832
SAMPLE CONCENTRATOR	EXT Area	January-05	January-05	new	OA-SYS	SN 20018
SAMPLE CONCENTRATOR	EXT Area	January-05	January-05	new	OA-SYS	SN 20019
WET CHEMISTRY	**Location**	**Date Received**	**Date in Service**	**Condition**	**MAKE/MODEL**	**SERIAL NUMBER**
TOX	Wet Chemistry	January-97	January-97	new	MITSUBISHI TOX-10E	N/A
TOC (1)	Wet Chemistry	June-08	June-08	new	Shimadzu TOC-V CSH	H51104535288CS
	Wet Chemistry	January-97	January-97	new	Shimadzu Solid Module	H52504500370
	Wet Chemistry	January-97	January-97	new	Shimadzu Autosampler	H52104502483
AUTOANALYZER	Wet Chemistry	June-08	June-08	new	LACHET QUICK CHEM AE	200-474
IC	Wet Chemistry	October-00	October-00	new	DIONEX LC20/ED40/AD20/AS40	900915
COD REACTOR #4	Wet Chemistry	January-97	January-97	new	HACH COD REACTOR	910404575/920800007697
COD REACTOR #5	Wet Chemistry	January-11	January-11	new	Lovibond CSB/Reactor ET125	0310/4260
TURBIDIMETER	Wet Chemistry	January-97	January-97	new	HACH 2100P	960700011424
SPECTROPHOTOMETER	Wet Chemistry	January-97	January-97	new	HACH #3 DR 2800	1209697
SPECTROPHOTOMETER	Wet Chemistry	January-97	January-97	new	HACH #4 DR 2800	11996-79
TITRATOR	Wet Chemistry	January-97	January-97	new	METTLER TOLEDO DL53	S119484414
VISCOMETER	Wet Chemistry	January-97	January-97	new	BROOKFIELD DVII	32587
WATER BATH	Wet Chemistry	January-97	January-97	new	BROOKFIELD TC-200	GCAL# 0311
CLOSED CUP FLASH PT	Wet Chemistry	January-97	January-97	new	PRECISION SCIENTIFIC	10BR-12
FLASHPOINT (FP3)	Wet Chemistry	December-08	December-08	new	Herzog HFP 339	083390442
AMMONIA PROBE	Wet Chemistry	January-97	January-97	new	ORION 95-12	N/A
OXYGEN BOMB CAL	Wet Chemistry	January-97	January-97	new	PARR	6616
CONDUCTIVITY METER 2	Wet Chemistry	January-11	14/11	new	OAKTON pH/CON 510 SERIES	528330
COLIFORM BATH 1	Wet Chemistry	January-92	January-92	new	PRECISION SCIENTIFIC INCUBATOR	10AZ-1
COLIFORM BATH 2	Wet Chemistry	May-08	May-08	new	THERMOSCIENTIFIC INCUBATOR	204785
COLIFORM BATH 3	Wet Chemistry	May-09	May-09	new	THERMOSCIENTIFIC INCUBATOR	207063
PH METER	Wet Chemistry	January-97	January-97	new	ORION 720A+	092891
PH PROBE 04/ATC PROBE	Wet Chemistry	January-97	January-97	new	ORION SURE-FLOW ROSS 8102BNUWP	LUI-18038
PH METER	Wet Chemistry	January-97	January-97	new	ORION 420A	7881
PH PROBE	Wet Chemistry	January-97	January-97	new	*ORION TRIODE*	*N/A*
PH PROBE/ATC PROBE	Wet Chemistry	January-97	January-97	new	*ORION COMB 915600/917006*	*N/A*
PH METER (PH-05)	Wet Chemistry	October-08	October-08	new	ORION 2STAR	B11765
PH PROBE	Wet Chemistry	January-97	January-97	new	ORION 9107APMD	RMR21
PH Meter (PH-07)	Wet Chemistry	September-10	September-10	new	Thermo Scientific/Dual Star	E03025
AUTOCLAVE	Wet Chemistry	September-10	September-10	new	Tuttnauer	10003285
DO METER	Wet Chemistry	January-97	January-97	new	YSI MODEL 59/5905 PROBE	93A01946
DO METER	Wet Chemistry	March-10	March-10	new	YSI MODEL 5100	10A 101264
OVENS (2)	Wet Chemistry	January-97	January-97	new	BLUE M SW17TA-1	SW-5478/SW-5408
OVEN	Wet Chemistry	January-97	January-97	new	FISHER SCIENTIFIC 3510-ISF	1879070606147

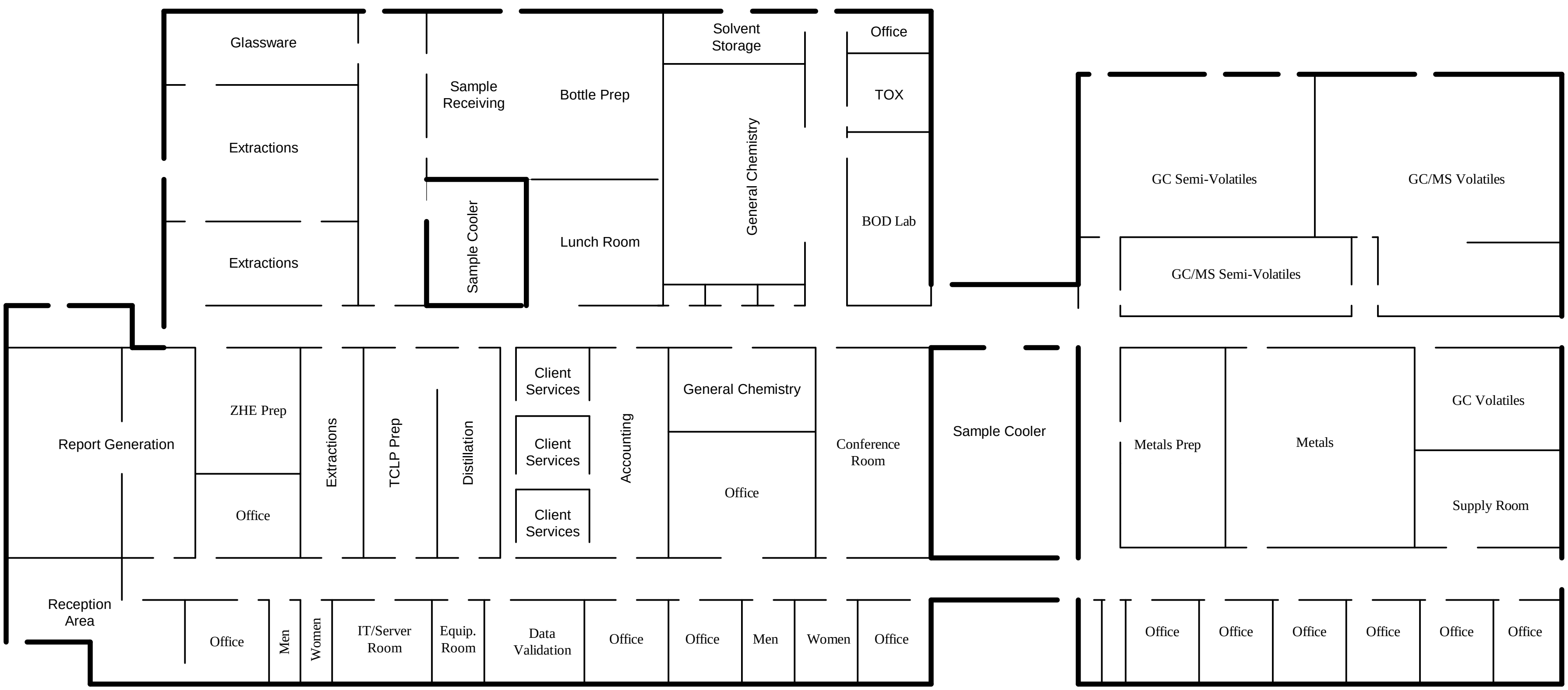
GCAL Equipment List

OVEN	Wet Chemistry	January-97	January-97	new	GRIEVE PL-326	444341
OVEN	Wet Chemistry	January-97	January-97	new	FISHER SCIENTIFIC ISOTEMP/MODEL 516G	506NO196
OVEN	Wet Chemistry	January-97	January-97	new	FISHER SCIENTIFIC ISOTEMP/MODEL 650G	508N0138
OVEN	Wet Chemistry	January-97	January-97	new	FISHER SCIENTIFIC ISOTEMP/MODEL 650G	508N0137
FURNACE	EXT area	January-97	January-97	new	THERMOLYNE 1500	N/A
DESSICATORS (7)	Wet Chemistry	January-97	January-97	new	DRY KEEPER	N/A
INCUBATOR	Wet Chemistry	January-97	January-97	new	FISHER SCIENTIFIC(#3)	WB93928030
BALANCE	Wet Chemistry	January-97	January-97	new	METTLER AE160	C05693
BALANCE	Wet Chemistry	January-97	January-97	new	METTLER AX504	1122043050
BALANCE	Wet Chemistry	January-97	January-97	new	SARTORIUS / PT6-000V2	60802675
BALANCE	Wet Chemistry	January-97	January-97	new	FISHER SCIENTIFIC / ACCU-224	F224075004
FUME HOODS (5)	Wet Chemistry	January-97	January-97	new	N/A	N/A
INCUBATOR (BOD#6)	Wet Chemistry	January-97	January-97	new	REVCO	T28C-142152-TC
INCUBATOR (BOD#2)	Wet Chemistry	January-97	January-97	new	PRECISION SCIENTIFIC	10AZ-12
INCUBATOR (BOD#7)	Wet Chemistry	January-97	January-97	new	FISHER SCIENTIFIC	407N0211
INCUBATOR (BOD#5)	Wet Chemistry	January-97	January-97	new	FISHER SCIENTIFIC	WB93928030
INCUBATOR (BOD#8)	Wet Chemistry	January-97	January-97	new	FISHER SCIENTIFIC	WB53337398
INCUBATOR (BOD#9)	Wet Chemistry	January-97	January-97	new	FISHER SCIENTIFIC	2018080398339
INCUBATOR (BOD#10)	Wet Chemistry	January-97	January-97	new	FISHER SCIENTIFIC	2018080607337
REFRIG/FREEZER	Wet Chemistry	January-97	January-97	new	SEARS (#19)	LA91905856
REFRIG/FREEZER	Wet Chemistry	January-97	January-97	new	WHITE WESTINGHOUSE (#1)	WB10507478
VACUUM PUMP	EXT Area	May-08	May-08	new	Edwards	7643558
GRINDING MILL	Wet Chemistry	January-97	January-97	new	THE STRAUB CO./MODEL 4E	N/A
LOG-IN	**Location**	**Date Received**	**Date in Service**	**Condition**	**MAKE/MODEL**	**SERIAL NUMBER**
FUME HOOD (1)	LOGIN Area	January-97	January-97	new	FUME HOOD #9	N/A
COOLER	LOGIN Area	January-97	January-97	new	TRUE (#2)	708391
COOLER	LOGIN Area	January-97	January-97	new	TRUE (#3)/GDM-72	1-3792963
WALK-IN COOLER (2)	LOGIN Area	January-97	January-97	new	N/A	N/A
REFRIG/FREEZER	LOGIN Area	January-97	January-97	new	KENMORE (#4)	BA01902878
IR THERMOMETER	LOGIN Area	May-08	May-08	new	FISHER SCIENTIFIC	72704761
REFRIG/FREEZER	LOGIN Area	January-97	January-97	new	FRIDGIDAIRE (#33)	BA454622395
FREEZER	LOGIN Area	January-97	January-97	new	FRIGIDAIRE(#27) MFU17F3GW6	WB03102969
SCANNER	LOGIN Area	January-97	January-97	new	HEWLETT PACKARD SCANJET 5470C/C9850	CN1B41HOTZ
FREEZER	LOGIN Area	May-11	May-11	new	FRIGIDAIRE (#44) LFFH21F7HWG	WB11142000
FREEZER	LOGIN Area	January-97	January-97	new	FRIGIDAIRE (#29) FFC15C4CWO	WB40427812

Appendix D

GCAL

Facility Floor Plan



Approximate Square Footage: 22,000 Sq. Ft.

Scale: 1 in. = 25 ft.

Sample Receiving/Bottle Prep:	1420	GCMS Volatiles:	1229
Extractions/Prep:	3206	GCMS Semi-Volatiles:	394
General Chemistry:	2025	GC Volatiles:	423
Metals:	890	GC Semi-Volatiles:	906
Metals Preparation:	450	Report Generation:	713
Supply Room:	616	Offices/Storage:	8251
Walk-In Coolers	734	Waste Handling	640

Revised: March -2012

Appendix E

CERTIFICATIONS

Scopes of Accreditation are maintained by the QA/QC department and are available for review upon request.

< State of Illinois Environmental Protection Agency, NELAP Accreditation #200048, Certification No. 001202 (Expiration: February 2012)

< State of California Environmental Laboratory Accreditation Program, (Expiration: May 2013)

< State of New Jersey, Department of Environmental Protection (Expiration: June 2012)

< State of Florida, Department of Health, Bureau of Laboratories, NELAP, Lab ID: E87854 (Expiration: June 2012)

< South Carolina Department of Health and Environmental Control, Environmental Laboratory Certification Program, Certificate Number: 73006001 (Expiration: June 2012)

< Louisiana Department of Environmental Quality, Environmental Laboratory Accreditation Program, NELAP, Certificate Number 01955 (Expiration: June 2012)

< Oklahoma Department of Environmental Quality, Laboratory Certification Program, ID # 9403 (Expiration: August 30, 2012)

< Texas Commission on Environmental Quality, Certificate Number: T104704178-11-3 (Expiration: September 30, 2012)

< State of Arkansas, Department of Pollution Control and Ecology, Laboratory Certification Program (Expiration: August 2012)

< State of Kansas, Department of Health and Environment, NELAP, Certificate No. E-10354 (Expiration: October 2012)

< Arizona Department of Health Services, License AZ0718 (Expiration: November 2012)

< State of North Carolina, Division of Water Quality Laboratory Certification Program, Certificate 618 (Expiration: December 2012)

< DoD ELAP, Certificate ADE-1482 (Expires September 2012)

< State of Georgia Environmental Protection Division accreditation based on LA NELAP

< State of Kentucky, Underground Storage Tank Branch, Certificate #95 (Expiration: December 12, 2012)

< State of Virginia, Division of Consolidated Laboratory Services, Certificate #1375 (Expiration: December 14, 2012

Appendix F

GULF COAST ANALYTICAL LABORATORIES, INC
STANDARD OPERATING PROCEDURES

SOP	METHOD	REVISION #	DATE
Extractions			
EXT-001	BNA Solid/Low/3550C	18	11/18/2011
EXT-002	Pest/PCB Low/3550C	16	12/23/2009
EXT-003	BNA Prep SEP Funnel/3510C	21	11/18/2011
EXT-004	BNA Prep Continuous/3520C	9	03/01/2011
EXT-010	Pest/PCB Prep SEP Fun/3510C	14	04/07/2010
EXT-011	Pest/PCB Prep Cont/3520C	9	03/01/2011
EXT-017	Herbicide Preparation	21	03/11/2011
EXT-019	ZHE Cleanup	7	03/01/2011
EXT-026	TCLP/1311	9	03/01/2011
EXT-027	TPHD Solid/Low Level Ext	14	12/02/2011
EXT-029	TPHD Prep SEP Funnel	12	10/27/2011
EXT-031	Herbicide Prep Soils	16	08/16/2010
EXT-032	pH-Solids & Wastes	10	04/05/2011
EXT-033	pH-Waters	8	12/18/2009
EXT-034	Orgphos Pest Soil Prep/8141A	11	12/22/2010
EXT-035	Orgphos Pest/SEP Fun/8141A	10	12/22/2010
EXT-036	TCLP-Volatiles/1311	7	01/06/2010
EXT-037	Pest-Organic Prep	10	12/14/2011
EXT-038	BNA-Organic Prep	8	03/01/2011
EXT-050	BNA Sep OLM04.2	6	01/05/2010
EXT-051	Pest/PCB OLM04.2	5	01/05/2010
EXT-052	Oil & Grease-1664	15	04/01/2011
EXT-056	PAH/Soil/3550C	7	12/23/2009
EXT-057	PAH/Water/3510C	8	03/07/2011
EXT-058	Sulfuric Acid/Permanganate Clean-up	4	01/05/2010
EXT-059	Florisil Clean-up	4	01/05/2010
EXT-064	Oil & Grease/Soxhlet-29B	8	04/29/2011
EXT-065	Explosives Prep/Soil Samples	8	01/04/2010
EXT-066	Explosives Prep/Water Samples	7	04/22/2010
EXT-068	Formaldehyde Derivatization/Soil	5	03/07/2011
EXT-069	Formaldehyde Derivatization/Water	6	03/07/2011
EXT-070	SPLP/1312 Water & Solids	3	02/01/2010
EXT-071	SPLP-Volatiles/1312 Water & Solids	1	10/09/2003
EXT-073	Extraction of Tissue Samples	4	03/14/2011
EXT-074	% Lipids in Tissue	5	10/27/2011
EXT-076	625 SIM/Water	4	12/21/2009
EXT-077	Method 619 Extraction	4	08/16/2010
EXT-078	Formaldehyde Extraction	1	12/22/2009
EXT-079	Homogenizing Tissue	0	06/27/2011
GC			
GC-002	Volatiles/602	9	04/11/2011

GULF COAST ANALYTICAL LABORATORIES, INC
STANDARD OPERATING PROCEDURES

SOP	METHOD	REVISION #	DATE
GC-004	DRO/ORO	18	12/14/2011
GC-006	Gasoline Range Organics	16	09/13/2010
GC-007	TPH by Texas 1005/1006	10	02/28/2012
GC-008	Organophosphorous Pest/8141A	7	05/24/2010
GC-011	Chlorinated Herbicides/8151A	10	09/29/2011
GC-012	Pesticides/PCB 608	8	02/21/2011
GC-013	Pesticides/8081B	14	09/29/2011
GC-022	BTEX/8021A	8	04/28/2011
GC-023	PCB/8082A	13	11/11/2011
GC-024	Dissolved Gas/RSK-175	7	09/06/2011
GC-025	EPH-Extractable Pet. Hydrocarbons	7	02/28/2012
GC-028	Methanol/NCASI Method	4	11/25/2011
GC-029	Methanol/Method 8015D	6	07/27/2010
GC-031	Florida PRO	8	11/11/2011
GC-032	Volatile Petroleum Hydrocarbons	3	02/07/2011
GC-033	Triazine Pesticides – Method 619	3	02/22/2011
GC-034	Method 8011	7	09/29/2011
GC-035	Oklahoma GRO	0	01/31/2012

GCMSSV

GCMSSV-001	Semivolatiles/8270C	20	02/13/2012
GCMSSV-002	Semivolatiles/625	12	02/14/2012
GCMSSV-003	Semivolatiles/625 SIM	4	09/29/2011
GCMSSV-004	Semivolatiles/8270D	7	02/13/2012
GCMSSV-005	Parent/Alkyl PAH	1	09/29/2011

GCMSV

GCMSV-002	Volatiles/624	11	03/31/2011
GCMSV-003	Volatiles/8260B	23	09/14/2011
GCMSV-004	Oxygenates/8260B	1	03/07/2011

General Laboratory

GEN-001	Laboratory Glassware Prep.	5	10/02/2006
GEN-002	Balance Calibration	8	05/05/2010
GEN-003	Temperature Monitoring	11	03/23/2011
GEN-005	Mechanical Pipette Calibration	5	09/29/2006
GEN-006	Standard Preparation	7	06/17/2010
GEN-007	GCAL Training	7	04/11/2011
GEN-008	Documentation of Data (Logbooks)	6	06/26/2002
GEN-009	Waste Handling	8	03/23/2011
GEN-010	General Lab Monitoring	8	04/11/2011
GEN-012	Preventive Maintenance	4	02/02/2010
GEN-013	Spill Clean Up	1	07/23/1998
GEN-015	Laboratory Contingencies	1	08/31/2000

GULF COAST ANALYTICAL LABORATORIES, INC
STANDARD OPERATING PROCEDURES

SOP	METHOD	REVISION #	DATE
GEN-018	Non-conformances/Corrective Actions	5	05/14/2010
GEN-019	Project Specific Requirements	2	03/10/2010
GEN-020	Standard Tracking	1	05/06/2010
GEN-021	Calibration Modules for Target	0	05/26/2009
GEN-022	Linear Least Square Regression	0	05/26/2009
HPLC			
HPLC-001	PAH'S/8310	12	9/29/2011
HPLC-003	Explosives/8330A	8	03/24/2011
HPLC-004	Formaldehyde by HPLC (8315A)	6	09/06/2011
HPLC-008	Explosives/8330B	0	02/28/2012
Lab Administration/General			
LAD-001	Master Signature List	3	07/14/1998
LAD-002	Visitor Procedure	4	02/26/2003
LAD-003	Report Generation	9	09/06/2011
LAD-005	Vehicle Inspection	3	07/14/1998
LAD-008	Postage Machine	7	11/10/2009
LAD-009	Mail	7	11/10/2009
LAD-011	Answering the Telephone	7	11/09/2009
LAD-012	Sending a Fax	6	09/15/2006
LAD-013	Receptionist/Arriving and Departing	9	11/10/2009
LAD-014	Project Management	9	06/08/2010
LAD-018	Confidentially	4	03/15/2007
LAD-019	Data Assembly	1	03/11/2011
LADNR			
LADNR-001	29B Sample Preparation	1	04/29/2011
LADNR-002	29B Saturated paste	1	04/29/2011
LADNR-003	29B Soluble Cations and SAR	0	04/04/2011
LADNR-004	29B Cation Exchange Capacity	1	04/29/2011
LADNR-005	29B Electrical Conductivity	0	04/04/2011
LADNR-006	29B ESP	0	04/04/2011
LADNR-007	29B Leachable Chlorides Test	0	04/04/2011
LADNR-008	29B True Total Barium	0	04/04/2011
LADNR-009	29B Leachable TPH Test	0	04/04/2011
Metals			
MET-001	Glassware Prep-Metals	8	11/09/2009
MET-004	Digestion Solids/3050B	14	03/28/2011
MET-005	Digestion for ICP-water	14	03/28/2011
MET-006	Digestion for Mercury	19	05/19/2010

GULF COAST ANALYTICAL LABORATORIES, INC
STANDARD OPERATING PROCEDURES

SOP	METHOD	REVISION #	DATE
MET-008	Mercury Analysis	17	09/21/2010
MET-010	ICP Analysis	18	05/19/2010
MET-013	Hardness/Calc. Method	5	11/02/2009
MET-018	Microwave Digestion/Organics	5	02/22/2011
MET-019	Total Recoverable Metals	2	11/09/2009
MET-020	ICP Water Preparation/200.7 & 200.8	3	03/28/2011
MET-021	ICP MS Analysis	2	07/15/2011
Quality Assurance			
QA-001	Document Control	9	08/10/2010
QA-002	Data Reduction Validation	7	07/08/2010
QA-003	Report Validation	5	7/19/2010
QA-004	Laboratory Audits	4	04/19/2011
QA-007	Data Archive	5	06/14/2010
QA-008	Generation of SOP's	5	04/11/2011
QA-009	Determination of MDL's	9	01/30/2007
QA-010	Proper Handling of Raw Data	4	11/02/2006
QA-011	Data Integrity and Ethical Practices	3	08/28/2004
QA-012	Control Charts	4	05/03/2011
QA-013	Estimation of Uncertainty	2	06/14/2010
QA-014	Demonstration of Capability	2	06/10/2010
QA-015	Performance Evaluation Studies	1	06/17/2010
Sample Administration			
SAD-001	Sample Log-In	17	02/28/2012
SAD-002	Sample Custodian	10	03/14/2011
SAD-003	Sample Kit Preparation	9	03/14/2011
SAD-004	LIMS Log-In Procedure	9	03/14/2011
SAD-006	Sample Couriers	0	11/17/2010
Wet Lab (General Chemistry)			
WL-002	Total Solids	10	04/12/2011
WL-003	Total Dissolved Solids	11	01/25/2012
WL-004	Total Suspended Solids	12	03/14/2011
WL-005	Vol. Suspended Solids	8	03/14/2011
WL-006	Sulfate/Turbidimetric	10	09/28/2011
WL-007	Sulfite	7	03/10/2011
WL-008	Color	8	09/28/2011
WL-009	Paint Filter Test	10	03/10/2011
WL-012	Hexavalent Chromium	10	04/05/2011
WL-014	Phenols	10	11/01/2011
WL-015	Cyanide	9	05/18/2010
Wl-015a	Cyanide –South Carolina	1	11/19/2009
WL-016	Chlorine	8	09/28/2011

GULF COAST ANALYTICAL LABORATORIES, INC
STANDARD OPERATING PROCEDURES

SOP	METHOD	REVISION #	DATE
WL-017	Fluoride	8	09/28/2011
WL-018	BOD	20	05/19/2010
WL-019	Specific Gravity	9	03/14/2011
WL-021	COD/HACH	11	01/25/2012
WL-022	Ash/D482-80	11	04/14/2011
WL-025	Surfactant	7	05/18/2010
WL-026	Fecal Coliform	13	03/14/2011
WL-028	Silica	8	03/10/2011
WL-029	Specific Conductance	7	02/17/2010
WL-032	Turbidity	9	11/04/2010
WL-033	Sulfide/MB	10	09/28/2011
WL-034	Total Phosphorus	10	11/01/2011
WL-035	Total Settable Solids	6	04/19/2011
WL-037	TOX	5	04/11/2011
WL-038	Chlorides	9	09/28/2011
WL-041	Nitrate/Nitrite/N+N	10	09/28/2011
WL-042	Anions by Ion Chromatography	16	09/28/2011
WL-043	TOC Waters	11	09/02/2011
WL-044	Heat of Combustion	8	03/10/2011
WL-045	TKN/Titration	8	09/13/2010
WL-046	NH3 by ISE	11	02/22/2011
WL-047	Ferrous Iron	6	09/28/2011
WL-048	Orthophosphate	10	09/28/2011
WL-051	Sulfide Titration	8	03/10/2011
WL-052	Viscosity	4	03/10/2011
WL-054	Reactive Cyanide & Sulfide	9	05/18/2010
WL-056	Corrosivity Towards Steel	7	03/14/2011
WL-057	TOC Solid	3	10/11/2010
WL-060	Flashpoint-Automated	6	03/10/2011
WL-061	Water by Karl Fisher	3	03/10/2011
WL-062	Automated Ammonia Titration	6	09/13/2010
WL-063	Automated Alkalinity	7	03/14/2011
WL-064	Automated Low Alkalinities	6	03/14/2011
WL-066	Ignitability of Solids	4	03/10/2011
WL-068	Perchlorate	2	01/11/2010
WL-069	Total Acidity	3	03/14/2011
WL-070	Volatile Fatty Acids	4	03/12/2012
WL-073	Desiccator Monitoring	1	11/09/2009
WL-074	Acrylic Acid	0	02/09/2012

APPENDIX G

QAPP for Tissue Homogenization, Preparation and Analysis

Introduction

GCAL has performed tissue analysis for over a decade in support of remedial investigation and risk assessment studies. The analytical analysis of tissues is performed over a wide range of tests, including trace metals and mercury, PAHs, PCBs, and lipid determination. GCAL is accredited through the Louisiana DEQ for tissue analysis with an extensive scope of accreditation in this area.

Each type of tissue sample represents a unique challenge due to the sample matrix. GCAL has developed methods to deal with tissue homogenization, sample prep, clean-up, and analysis of tissue samples. All lab procedures are documented in laboratory SOPs. The analytical techniques follow SW-846 methodologies; including instrument calibration, QC requirements, and detection limit studies. All analysts performing sample prep and analysis must complete a demonstration of capability.

Sample Receipt and Chain of Custody

Samples are received at the laboratory, generally on ice, and following all sample receipt requirements outlined in SOP SAD-001. All samples are logged into the LIMS system, and given unique sample identification. Samples will then be transferred to the laboratory for homogenization or stored in a temperature controlled and monitored freezer. GCAL uses a bar code system for sample chain of custody and tracking, which is stored in the LIMS from receipt through disposal. Unused samples are stored frozen for a period of 60 days following receipt unless other arrangements are agreed upon. Please note that GCAL does not accept samples that require radiation treatment to destroy potential biological hazards such as rabies.

Tissue Homogenization

All tissue samples are subjected to homogenization and/or dissection techniques prior to analysis, which are designed to ensure a representative sub-sample is obtained for each analytical parameter. Refer to SOP EXT-079 for detailed procedures for tissue homogenization. The procedures used may vary significantly depending on the tissue type, the technical specifications of the project, and the requested analysis. Special blades are employed when metals analysis is requested to avoid contamination of samples. Following homogenization, a representative sub-sample is placed in a labeled pre-cleaned jar(s) and transferred to the appropriate departments for sample prep and analysis. Any unused portions are labeled and frozen.

Tissue Prep for Semi-volatile Organic Analysis

Sample prep is dependant on the project requirements including detection limits. The sample weight and final extract volume is carefully selected in order to achieve requested reporting limits and limit sample matrix interferences. Homogenized tissues are thawed, and then further homogenized by grinding in a mortar and pestle and mixing with C18. Samples are then extracted with solvent. Clean-up procedures selected depend on the requested analysis and sample matrix. These may include silica gel clean-up for PAHs and acid clean-up for PCBs. All samples are prepped with quality control samples, including method blanks, blank spikes (LCS), and matrix spikes (if sample volume is sufficient). All samples are spiked with surrogate standards as required by the method. Refer to SOP EXT-073 for detailed procedures for tissue prep.

Lipids Determination

Lipids are analyzed gravimetrically. A homogenized sample is weighed and extracted in methylene chloride using sonication. The extract is allowed to air dry and the residue is weighed. Results are reported as percent lipids. Refer to SOP EXT-074 for complete details on Lipid Determination in tissue.

Tissue Prep for Trace Metal and Mercury Analysis

Tissue prep of trace metals is typically performed in a closed Teflon vessel under high temperature and pressure. For mercury, the laboratory follows similar procedures as for other solids, except the initial sample weight is larger (typically 6 grams). This allows a more representative sub-sample for tissues. The digestion procedure is carried out using similar ratios of digesting/oxidizing reagents as suggested in SW-846 procedures to account for the larger sample volume.

Sample Analysis

There are typically no modifications needed for the analysis of tissue extracts/digestates. Procedures are outlined in laboratory SOPs.

APPENDIX H

GLOSSARY

ACCEPTANCE LIMITS – data quality limits specified by the test method or generated by the laboratory. Specified limits placed on an item, process, or service defined in the requirement document.

ACCURACY – a measure of how close a measured value is to a known true value. Accuracy is assessed by means of reference samples and percent recoveries of spiked samples. The degree of agreement between an observed value and an accepted reference value. Accuracy includes combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

ALIQUOT – a discrete, measure, or representative portion of a sample taken for analysis.

ANALYTE – the chemical element or compound an analyst seeks to determine; the chemical element of interest.

ANALYTICAL BATCH – the basic unit for analytical quality control, defined as samples that are analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each batch should be of similar composition (e.g., groundwater, sludge, ash).

ANALYTICAL SAMPLE – any solution or media introduced into an instrument on which an analysis is performed, excluding instrument calibration, initial calibration verification, initial calibration blank, continuing calibration verification, and continuing calibration blank. The following are all analytical samples: undiluted and diluted samples (EPA and non-EPA), predigestion spike samples, duplicate samples, serial dilution samples, analytical spike samples, post digestion spike samples, interference check samples (ICS), CRDL standard for AA(CRA), CRDL standard for ICP(CRI), laboratory control sample(LCS), preparation blank(PB), and linear range analysis sample(LRS).

ANALYST – the designated individual who performs the "hands on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

AREA UNITS – a term used in gas chromatography that indicates the peak area of a compound exiting a chromatographic column. The size or area of the peak is proportional to the amount of analyte in the sample.

ATOMIC ABSORPTION (AA) – a technique for analyzing metal using an element-specific lamp that emits a characteristic light spectrum. A sample is heated in a flame or graphite furnace and the light beam is passed through it. When the sample absorbs light, an energy loss is detected and is translated into a concentration of metal in the sample. This technique detects one metal at a time.

AUDIT – a systematic check to determine the quality of some function or activity. Two basic types are performance audits and system audits. Perform audits involve a quantitative comparison of the laboratory's results to those of a proficiency sample containing known concentration of analytes. A system audit is a qualitative evaluation that normally consists of an onsite review of a lab's quality assurance system and physical facilities.

BACKGROUND CORRECTION – a technique usually employed relative to metals analysis, which compensates for variable background contribution to the instrument signal in the determination of trace elements.

BATCH – environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A batch is composed of a maximum of twenty environmental samples. A preparation batch is composed of environmental sample of the same matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) and/or those samples not requiring preparation, which are analyzed together as a group using the same calibration curve or factor. An analytical batch can include samples originating from various environmental matrices.

BIAS – the deviation of the mean of replicate analytical measurements from a reference analyte concentration. Relative bias is represented by analytical measurement mean minus the reference analyte concentration and the difference divided by the reference analyte concentration. See accuracy and precision.

4-BROMO-FLUOROBENZENE (BFB) – the compound used to check the tuning of the instrument, and is used as a surrogate compound spiked into every sample for volatile analysis. A compound utilized in EPA gas chromatography/mass spectrometry (GC/MS) volatile methods to establish mass spectral instrument performance.

BIOCHEMICAL OXYGEN DEMAND (BOD) – A measure of the amount of oxygen consumed in the biochemical processes that break down organic matter in water. A larger BOD value indicates a greater degree of organic pollution. A related term, BOD5, is the amount of dissolved oxygen consumed in five days.

BIOSEED – the bacterial culture used to inoculate a sample for testing.

BLANK – an artificial sample designed to monitor the introduction of artifacts into the measurement process. For aqueous samples, reagent water is used as a blank matrix. There are several types of blanks, which monitor a variety of processes:1.) *laboratory blank* is taken through sample preparation and analysis only. It is a test for contamination in sample preparation and analyses. 2.) *storage blank* is stored and analyzed with samples at the laboratory. It is a test for contamination in sample storage as well as sample preparation and analysis. 3.) *trip blank* is shipped to and from the field with the sample containers. It is not opened in the field and, therefore, provides a test for contamination from sample preservation, site conditions, and transport as well as sample storage, preparation, and analysis. It is most commonly used for volatile organics. 4.) *field blank* is opened in the field and tests for contamination from the atmosphere as well as those activities listed under the trip blank.

BNA – base, neutral and acid extractable compounds. The term base, neutral and acid refer to the pH condition of the sample undergoing extraction. Certain compounds extract more efficiently from water under acidic conditions. Such compounds are often referred to as "acid extractables."

CALIBRATE – to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device, or the correct value for each setting of a control knob. The levels of the applied calibration standard should bracket the range of planned or expect sample measurements.

CALIBRATION – The systematic determination of the relationship of the response of the measurement system to the concentration of the analyte of interest. Instrument calibration performed before any samples are analyzed is called the initial calibration. Subsequent checks on the instrument calibration performed throughout analysis are called continuing calibration verification.

CALIBRATION BLANK (CB) – a volume of reagent water in the same matrix as the calibration standards but without the analyte.

CALIBRATION CURVE – the graphical relationship between the known values, such as concentrations, of a series of calibration standards and their analytical response.

CALIBRATION METHOD – a defined technical procedure for performing a calibration.

CALIBRATION STANDARD – a certified material used to calibrate an instrument.

CERTIFIED REFERENCE MATERIAL (CRM) – reference material, one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30)

CONTINUING CALIBRATION VERIFICATION (CCV) – used to evaluate the performance of the instrument system with respect to a defined set of method criteria. The CCVs are used to verify instrument performance during analysis. The CCV shall be prepared from the same stock standard solution used to prepare the calibration curve.

CHAIN-OF-CUSTODY–Procedures and associated documents designed to trace the custody of a sample from the point of origin to final disposition, with the intent of legally demonstrating that custody remained intact and the tampering or substitutions were precluded.

CHEMICAL OXYGEN DEMAND (COD) – A measure of the oxygen required to oxidize all compounds in water, both organic and inorganic.

COMBINED STANDARD UNCERTAINTY – The standard uncertainty of the analytical measurement result that is the sum in quadrature (square-root-of-the-sum-of-the-squares) of the component standard uncertainties.

CORRECTIVE ACTION – the action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation to prevent reoccurrence.

COVERAGE FACTOR – the numerical factor used as a multiplier of the combined standard uncertainty to expand the uncertainty corresponding to a specific level of confidence. The Student's *t*-distribution is used for determining the coverage factor.

DEMONSTRATION OF CAPABILITY (DOC) – a procedure used to establish the ability of the analyst to generate acceptable accuracy.

DEIONIZED WATER (DI) – water from which the majority of ions have been removed. Water that is contaminant free and used in the laboratory, the resistivity should be ≤ 18 megaohms.

DISSOLVED METALS –- metallic elements determined on a water sample that has been passed through a 0.45-um filter.

DISSOLVED OXYGEN (DO) – the oxygen freely available in water, an indicator of water quality.

DISSOLVED SOLIDS – disintegrated organic and inorganic material contained in water. Excessive amounts make water unfit to drink or use in industrial processes.

DRY WEIGHT – the weight of a sample based on percent solids. The weight of a sample after drying in an oven at a specified temperature.

DUPLICATE MEASUREMENT – a duplicate measurement is a second measurement made on the same or identical sample of material to assist in the evaluation of measurement of variance.

DUPLICATE SAMPLE – two samples taken from the same population and carried through certain stages of sampling and testing. Duplicate sample include field co-located duplicate samples, field-split duplicate samples, and laboratory duplicate subsamples.

EXPANDED UNCERTAINTY – the quantity defining an interval enveloping the analytical measurement that captures a large fraction of the distribution of analyte concentrations that could be attributable to the quantity measured. The combined standard uncertainty is multiplied by the coverage factor to calculate the expanded uncertainty.

EXTERNAL STANDARDS – a method of quantifying chromatographic data in which standards of known concentration are analyzed prior to unknown samples. The chromatographic peak area (or height) of a sample component is compared to a calibration curve of a peak area constructed from the standard data for that component. This comparison allows the concentration of the component in the sample to be determined.

FECAL COLIFORM BACTERIA – bacteria found in mammals' intestinal tracts. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens.

FLAME IONIZATION DETECTOR (FID) – a gas chromatography detector in which the column effluent gas is mixed with hydrogen and burned in air or oxygen. The ions and electrons produced in the flame generate an electric current proportional to the amount of materials in the detector. The FID responds to nearly all organic compounds, but it does not respond to air and water, which makes it exceptionally suited to environmental analysis.

FLASHPOINT – the lowest temperature at which a flammable liquid gives off sufficient vapor to form an ignitable mixture with air near its surface or within a vessel. Combustion does not continue.

GAS CHROMATOGRAPHY (GC) – a technique for detecting organic compounds by using their physical and chemical properties to separate a mixture. The compounds are identified and quantified with various types of detectors as they exit the chromatograph. Selection of detectors is dependent on the particular compounds of interest.

GAS CHROMATOGRAPHY MASS SPECTROMETRY (GCMS) – a technique in which sample analytes are bombarded with electrons as they exit a gas chromatography column and are fragmented into characteristics ion patterns. The mass spectrometer is the detector. It can determine which fragments are present and therefore the identity of the compounds.

GLUCOSE GLUTAMIC ACID (GGA) – used as a laboratory control standard in BOD procedures.

GRAPHITE FURNACE – a technique used for the analysis of metals. An atomic absorption spectrophotometer heats the sample within a graphite tube using an electrical current. It is also commonly called a flameless furnace and generally provides greater sensitivity for certain metals than flame or inductively coupled argon plasma techniques.

GRAVIMETRIC - analyses based on the direct or indirect weighing of the analyte in question. This technique usually requires the use of an analytical balance with a sensitivity of 0.1 mg or better.

HALL ELECTROLYTIC CONDUCTIVITY DETECTOR – an element-selective gas chromatography detector primarily intended for trace analysis of organic compounds containing chlorine, nitrogen or sulfur. In operation, this detector pyrolyzes the column effluent gas into soluble electrolytes that are dissolved in a stream of deionized liquid. The observed change in electrical conductivity, proportional to the amount of material present, is measured.

HAZARDOUS WASTE – waste regulated under RCRA that can pose a substantial or potential hazard to human health or the environment when improperly managed. Such wastes possess at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity) or appear on special EPA hazardous waste lists. The term is not interchangeable with hazardous substances or material.

HEADSPACE - Any area in a container not completely filled by the sample in which gases can collect.

HEAVY METALS – metallic elements with high atomic weights, i.e., mercury, chromium, cadmium, arsenic, and lead. They can damage the health of plants and animals at low concentrations and tend to accumulate in the food chain.

HOLDING TIME – the maximum times that samples may be held before analysis and still be considered valid or not compromised. The storage time allowed between sample collection and sample analysis when the designated preservation and storage techniques are employed.

HYDROCARBONS – chemical compounds that consist entirely of carbon and hydrogen.

ICP – Inductively coupled plasma is a type of instrument used for metals analysis. Because the temperature of the plasma is considerable higher (10,000^{o}K) than the temperature of a flame atomic absorption spectrophotometer, it is especially useful for refractory metals. Some instruments are also capable of performing simultaneous multielement analysis.

ICP-MS - Inductively coupled plasma mass spectrometry (ICP-MS) is a type of mass spectrometry highly sensitive and capable of the determination of a range of metals and several non-metals at concentrations below one part in 10^{12} (part per trillion). It is based on coupling together an inductively coupled plasma as a method of producing ions with a mass spectrometer as a method of separating and detecting the ions. In trace elemental analysis, the method has advantages of high speed, precision and sensitivity.

IGNITABLE – capable of burning or causing a fire.

INORGANIC CHEMICALS – chemical substances of mineral origin, unlike organic chemicals whose structure relies on carbon atoms.

INITIAL CALIBRATION VERIFICATION (ICV) - also referred to as the Independent Calibration Verification for this laboratory. A standard solution used to verify the calibration curve derived from a source independent of the instrument calibration standard. The ICV is use to quantify second source standard variance and bias.

INSTRUMENT CALIBRATION STANDARD - a reference material used to standardize an analytical instrument.

INSTRUMENT DETECTION LIMIT (IDL) - a term utilized in the EPA Inorganic Contract Laboratory Program. The IDL is three times the standard deviation obtained for the analysis of a standard solution (each analyte in reagent water) at a concentration of three to five times that of the IDL on three nonconsecutive days with seven consecutive measurements per day. The IDL is the concentration equivalent to a signal, due to the analyte of interest, which is the smallest signal that can be distinguished from background noise by a particular instrument. The IDL should always be below the method detection limit, and is not used for compliance data reporting, but may be used for statistical data analysis and comparing the attributes of different instruments.

INSTRUMENT PERFORMANCE CHECK - The analyses of one of the ICSs to verified initial and continuing calibration (CCV). The IPC is used to quantify the instrumental testing repeatability variance and bias.

INSTRUMENT TUNING - a technique used in gas chromatography/mass spectrometry procedures to verify that the instrument is properly calibrated to produce reliable mass spectral information. See 4-Bromofluorobenzene under “B”.

INTERNAL STANDARDS - compounds added to every standard, blank, matrix spike, matrix spike duplicate, sample (for volatile organics), and sample extract (for semivolatiles) at a known concentration, prior to analysis. Internal standards are used as the basis for quantification of the target compound.

IONIZATION - Utilized in mass spectrometry to fragment analyte molecules into smaller segments. These smaller mass segments are then separated and plotted to form a “mass spectrum” which is used to identify the parent molecule. Electron impact is one example of ionization used in mass spectrometry. In more technical terms. Ionization is the process by which neutral atoms or groups of atoms become electrically charged, either positively or negatively, by the loss or gain of electrons.

ISOMERS - chemical compounds with the same molecular weight and atomic composition by differing molecular structure, e.g., n-pentane and 2-methylbutane.

LABORATORY CONTROL SAMPLE (LCS) - a clean-matrix reference sample spiked with a standard with an established analyte concentration. The LCS is carried through the entire chemical preparation and testing procedures. The LCS is used to quantify the variance and bias of the chemical preparation and instrumental testing stages without matrix interference. Also called a Laboratory fortified blank (LFB).

LABORATORY CONTROL SAMPLE DUPLICATE (LCSD) – a duplicate of the laboratory control sample in a clean matrix that is carried through the entire chemical preparation and testing procedures.

LABORATORY DUPLICATE SAMPLE (LAB DUPLICATE) - a portion of the collected sample that is carried through the chemical preparation and testing. The laboratory duplicate subsample is used to quantify the variance of the chemical preparation and instrumental testing stages with matrix interferences.

LEACHATE - a liquid that results from water collecting contaminants as it trickles through wastes, agricultural pesticides or fertilizers. Leaching may occur in farming areas, feedlots, and landfills, and may result in hazardous substances entering surface water, groundwater or soil.

LDEQ – Louisiana Department of Environmental Quality

LIBRARY SEARCH - a technique in which an unknown mass spectrum of a compound is compared to the mass spectra of compounds contained in a computer library in an effort to identify the compound. Compounds identified in this manner are referred to as tentatively identified compounds (TICs).

LIMIT OF DETECTION (LOD) – an estimate of the minimum amount of a substance that an analytical process can reliable detect. An LOD is analyte and matrix specific and may be laboratory dependent.

LIMIT OF QUANTIATION (LOQ) – the minimum levels, concentrations, or quantities of a target variable (e.g. target analyte) that can be reported with a specified degree of confidence..

LIMS – laboratory information management system. Horizons is the LIMS used by GCAL.

LINEAR CALIBRATION RANGE – the concentration range over which the instrument response is linear.

LOG-IN - the receipt and initial management of an environmental sample. It generally includes identifying who sent the sample; maintaining chain-of-custody; checking report and invoice information; recording analysis requested, including methodology and special instructions; and assigning a discreet in-lab identification, usually a number or bar code.

MASS SPECTRUM - a plot of ion mass/charge ratio versus intensity. A fragmentation pattern results from the particles whose mass distribution is characteristic of the parent molecule. Qualitative information is provided by a mass spectrum.

MATERIAL SAFETY DATA SHEET (MSDS) - a compilation of information required under the OSHA Communication Standard on the identity of hazardous chemicals and their associated health and physical hazards, exposure limits and precautions.

MATRIX - The physical characteristics or state of a sample – e.g., water, soil, sludge.

MATRIX INTERFERENCE - the influence of the sample matrix or sample components upon the ability of qualitatively identifies and quantitatively measures compounds in environmental samples.

MATRIX MODIFIERS - chemicals added to samples for metals analysis, which are used to lessen the effects of chemical interference, viscosity and surface tension.

MATRIX SPIKE (MS) – aliquot of a sample fortified (spiked) with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery of the spike. Matrix spiked samples are used to quantify the variance and bias of the chemical preparation and testing stages with matrix interference.

MATRIX SPIKE DUPLICATE (MSD) - a second aliquot of the same matrix as the matrix spike that is spiked to determine the precision of the method.

METHOD DETECTION LIMIT (MDL) - the minimum concentration of compound that can be measured and reported within 99% confidence that the value is above zero and is determined from analysis of a sample in a given matrix containing the analyte.

MUST – denotes a mandatory requirement.

NARRATIVE - in an analytical report, a descriptive documentation of any problems encountered in processing the samples, along with corrective action taken and problem resolution.

NUTRIENT - any substance assimilated by living things that promote growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.

ORGANIC - generally, any compound that contains carbon bonded to a hydrogen or halogen atom.

OXIDATION - the process in chemistry whereby electrons are removed from a molecule.

PCBs - Polychlorinated biphenyl, a group of toxic persistent chemicals used in transformers and capacitors for insulating purposes and in gas pipeline systems as a lubricant. Sale of PCBs for new uses was banned by law in 1979.

PERCENT RECOVERY - a measure of accuracy that is calculated as the measured value relative to the true value expressed as a percent.

PERFORMANCE AUDIT - a quantitative evaluation of a measurement system that involves the analysis of standard reference samples or materials which are certified as to their chemical composition or physical characteristics.

PROFICIENCY TEST (PT) SAMPLE - a sample of known composition (unknown to the laboratory), provided by an external source, which is used to evaluate lab performance. For certification purposes the PT sample is purchased from an approved provider.

pH - a numerical designation of relative acidity and alkalinity. A pH of 7.0 indicates precise neutrality. Progressively higher values indicate increasing alkalinity and lower values increasing acidity.

POLLUTANT - generally, any substance introduced into the environment that adversely affects the usefulness of a resource.

PRACTICAL QUANTITATION LIMIT (PQL) - the lowest level that can be reliable achieved within specified limits of precision and accuracy routine laboratory operating conditions. The lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value.

PRECISION - a measure of the ability to reproduce analytical results. It is generally determined through the analysis of duplicate samples. The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range in either absolute or relative terms.

PRESERVATIVE - a chemical or reagent added to a sample to prevent or slow decomposition or degradation of a target analyte or a physical process. Physical and chemical preservation may be used in tandem to prevent sample deterioration.

PURGE AND TRAP - a technique used in the analysis of volatile organic where analytes are purged from a sample by means of an inert gas and trapped on a sorbent column. The sorbent is then flashheated and the analytes are transferred onto a gas chromatographic column for separation and identification.

PURGEABLE ORGANIC - an organic compound that is generally less than 20% soluble in water and has a boiling point at or below 200^{o}C. A volatile organic. An organic compound is generally considered to be purgeable if it can be removed from water using the purging process.

QC BASED NESTED APPROACH - a procedure for estimating the uncertainty of measurement using quality control data. The procedure is described in SOP QA-013.

QUALITY ASSURANCE (QA) - all those planned and systematic actions necessary to provide adequate confidence in laboratory results. An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets the defined standards of quality with a stated level of confidence.

QUALITY ASSURANCE PROGRAM PLAN - a written assembly of management policies, objectives, principle and general procedures that outlines how the laboratory intends to generate data of known and accepted quality.

QUALITY CONTROL (QC) – the overall system of technical activities whose purpose to measure and control the quality of a product or service so that it meets the needs of the users.

QUALITY CONTROL CHART - a graph of analytical measurement results for a specific QC standard plotted sequentially with upper and lower control limits (±3SD). A central line that is the best estimate of the average variable plotted, and upper and lower marginal exceedence limits (±4SD) are usually included in the Quality Control Chart. The chart may also include upper and lower warning limits (±2SD).

QUALITY SYSTEM – a structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items) and services. The quality system provides the framework for planning, implement and assessing work performed by the organization and for carrying out required QA and QC.

r^2 – Correlation Coefficient Squared – paramet6er used to evaluate the fit of linear or quadratic regression curve fit of initial calibration data.

RAW DATA – any original information from a measurement activity or study recorded in a laboratory note book, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfilm copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments.

REACTIVITY - the tendency of a chemical to explode under normal management conditions, to react violently when mixed with water, or to generate toxic gases.

REAGENT WATER - water in which an interference is not observed at or above the minimum quantitation limit of interest.

REFERENCE MATERIAL - a traceable standard with an established analyte concentration. Material or substance whose property values are sufficiently homogenous, stable and well established to be used for the calibration of an apparatus, the assessment of a measurement method or for assigning values to materials (ISO Guide 30)

REFERENCE METHOD – a method of known and documented accuracy and precision issued by an organization recognized as competent to do so.

RELATIVE RETENTION TIME – a measure of the shift in retention time of an analyte when referenced to an internal standard.

RELATIVE RESPONSE FACTOR (RRF) - a measure of the relative mass spectral response of an analyte compared to its internal standard. RRFs are determined by analysis of standards and are used in the calculation of concentrations of analytes in samples.

REPLICATE ANALYSES - two or more results representing the same sample parameter. Replicate analyses are used to quantify the analytical measurement repeatability precision.

RPD – Relative Percent Difference, a relative difference between two analyses calculated by dividing the absolute difference of thos two results by the average of therir two values, then multiplying by 100.

RESOLUTION - the degree of separation between peaks eluting from a chromatographic column. Sufficient resolution between peaks is required for proper quantitation of unknown analytes.

RETENTION TIME - a term used in gas and liquid chromatography describing the time elapsed from the sample injection until the specific compound elutes or exits the chromatographic column at the detector. Each compound has a characteristics retention time on a specific column; therefore, this information is used to qualitatively identify the compounds in the sample.

SAMPLE – portion of material collect for chemical analysuis, identified by a unique number assigned by the LIMS.

SHALL – denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled.

SHOULD – denotes a guideline or recommendation whenever noncompliance with the specification is permissible.

SOLID WASTE – non-liquid, non-soluble materials, ranging from municipal garbage to industrial waste, that contain complex, and sometimes hazardous, substances. Solid wastes include sewage sludge, agricultural refuse, demolition wastes, mining residues, and even liquids and gases in containers.

SOLVENT - a substance, usually liquid, capable of dissolving or dispersing one or more other substances.

SPIKE – a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

STANDARD CURVE - a curve that plots concentrations of known analyte standards versus the instrument response to the analyte. Calibration standards are prepared by diluting the stock analyte solution in graduated amounts that cover the expected range of the samples being analyzed. The calibration standards must be prepared by using the same type of acid or solvent at the same concentration as for the samples following sample preparation. This is applicable to organic and inorganic chemical analyses.

STANDARD OPERATING PROCEDURE - a detailed written description of how a laboratory executes a particular procedure or method intended to standardize its performance.

STANDARDIZED REFERENCE MATERIAL (SRM) – a certified reference material produced by the U.S. National Institute of Standards and Technology or other equivalent organization and characterized for absolute content, independent of analytical metho9d.

STANDARD UNCERTAINTY - the analytical measurement uncertainty expressed as a standard deviation. The relative standard deviation represents the relative standard uncertainty.

SURROGATE - an organic compound similar to the analyte of interest in chemical composition, extraction and chromatography, but not normally found in environmental samples. Primarily used in chromatography techniques, the surrogate is spiked into quality control blanks, calibration and check standards, samples (including duplicated and QC reference samples) and spiked samples before analysis. A percent recovery is calculated for each surrogate.

SUSPENDED SOLIDS - small pollutant particles that float on the surface of, or are suspended in, sewage or other liquids. They resist removal by conventional means.

TARGET COMPOUND - specific compounds that are to be quantified in a sample based on a standard list of potential compounds.

TENTATIVELY IDENTIFIED COMPOUNDS (TICs) - compounds detected in samples that are not target compounds, internal standards, system monitoring compounds or surrogates. TICs usually consist of up to 30 peaks that are greater than 10% of the peak areas, or heights, of the nearest internal standard. They are subjected to mass spectral library searches for tentative identification. A client may specify the number of unknown peaks in its samples it wishes the laboratory to tentatively identify.

TOTAL METALS - metallic elements that have been digested prior to analysis.

TYPE A EVALUATION UNCERTAINTY - the method of evaluation of uncertainty by the statistical analysis of a series of test results.

TYPE B EVALUATION OF UNCERTAINTY - the method of evaluation of uncertainty by means other than statistical analysis.

UNCERTAINTY - the parameter associated with the analytical measurement results that characterizes the dispersion of the values that could be reasonable attributed to the quantity measured.

UNCERTAINTY INTERVAL - the range of analyte concentrations that an analytical measurement could represent at a specified level of confidence. The relative standard deviation is used to represent the relative standard uncertainty in the QC-based Nested Approach.

VALIDATION –the process for evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual specifications. It essentially evaluates performance against predetermined specifications.

VOA - volatile organic analysis

VOA BOTTLE - a vial used to contain samples for volatile organic analysis.

VOLATILE COMPOUNDS - compounds amendable to analysis by purge and trap. Synonymous with purgeable compounds.

VOLATILE ORGANIC COMPOUND (VOC) - any organic compound that participates in atmospheric photochemical reactions, except for those designated by the EPA Administrator as having negligible photochemical reactivity.

WET CHEMISTRY - procedures that involve distillations, colorimetric determinations and titrimetric measurements. Examples are chloride, nitrates, sulfates and biochemical oxygen demand.

SUBJECT SCOPE AND APPLICATION

This is a purge and trap GC/MS method, which quantitatively identifies purgeable organic compounds. A list of target analytes is available in the LIMS.

A 5-mL water sample is purged, with helium at ambient temperature. The purgeable compounds are transferred to the vapor phase and are carried to the trap. Once the purging has been completed, the trap is heated and back flushed with helium to desorb the purgeable compounds onto the column. The compounds are then separated by their molecular weight, the column phasing and increasing temperature, and then detected by a mass spectrometer.

MATRIX Water and Solids

REFERENCE SW846 Methods 8260B, 5030B, 5030C, 5035A, 8000B, 8000C
NOTE: For North Carolina and South Carolina projects, Method SW846 8260B and 8000B must be used.

ANALYTE LIST Refer to Appendix A

PRESERVATIVE Cool <6°C Aqueous pH <2 with HCl and/or $Na_2S_2O_3$ (unless unpreserved requested)
Acrolein and Acrylonitrile pH 4-5 with $Na_2S_2O_3$, if unpreserved holding time is 3 days.

HOLDING TIME Water - 14 days from sample collection when preserved in HCl
Solid - 14 days from sample collection
Solid – Encore™ Samplers – 48 hours to preservation/then 14 days to analysis

Water samples that are target for Styrene, Vinyl chloride, and 2-CVE must be collected without HCL preservation and analyzed within 7 days of collection. If samples for these analytes are received with HCl preservative, the data must be qualified with a narrative in the final report.

Specific projects may require non-acid preservation of water samples. If water samples are unpreserved the analysis must be performed in 7 days.

Water samples must be checked for pH preservation after analysis unless a vial was provided for a pH check at sample receiving. Record the pH on the batch sheet. If the sample has a pH greater than 2 and the sample was analyzed after 7 days, narrate results.

DEFINITIONS See Appendix C

SAFETY Each employee is directly responsible for complete awareness of all health hazards associated with every chemical that he/she uses. The employee must be aware of these hazards, and all associated protective wear and spill clean-up procedures PRIOR TO the use of any chemical. In all cases, the applicable material safety data sheet (MSDS) and the supervisor or safety officer should be consulted. The bottle labels also provide important information that must be noted. Personnel performing this procedure may be working with flammables, poisons, toxins, carcinogens, teratogens, mutagens, and biohazards. In particular, approved gloves, safety glasses, and lab coats must be worn. In addition to other measures, solvents and chemicals must be handled in ventilated hoods.

INTERFERENCES Contamination can be related to impurities in the purge gas and solvent vapors in the lab. The system is shown to be free from contamination by running a reagent blank each 12-hour period.

Samples can be contaminated by diffusion of vapors through the septum seal during shipment and storage. A field blank can be prepared during sample collection and can act as a check for this type of contamination. Holding blanks are analyzed every two weeks to provide an additional check for this type of contamination. These holding blanks are stored in coolers C22, C30, and C4.

Contamination can also be seen when a low level sample is analyzed immediately after a high level sample. Freedom from contamination must be established before sample analysis is considered valid. After analysis of a sample containing high concentrations of volatile organic compounds, a blank should be analyzed to check for contamination. Alternatively, if the sample following the high concentration sample does not contain the volatile organic compounds present in the high level sample above quantitation limits, freedom from contamination has been established. If the blank or preceding sample shows contamination, analyze blanks until an acceptable blank is achieved and/or clean the purge vessel and bake trap. Reanalyze samples with potential carryover contamination.

INSTRUMENTATION & APPARATUS Agilent 6890 and 7890 GC with a 5973 or 5975 Mass Spectrometer coupled with a Teledyne Tekmar purge and trap and autosampler

HP5890 GC with 5972 Mass Spectrometer coupled with a Velocity XPT concentrator using a Solatek 72 or
Each instrument is assigned a maintenance logbook. All maintenance performed on the instrument must be recorded.

Target data acquisition system

Restek (Cat no. 19915) RTX-VMS 30m, 0.25um ID, 1.4 um df

Gas-tight syringes

Electronic Balance – capable of weighing to 0.01g

Volumetric flasks

44 mL VOA vials

2 mL autosampler vials

Glass culture tubes

Pasteur pipets

Magnetic stir bars

Scoopula spatulas

pH paper

REAGENTS

All organic solvent shall be of pesticide grade or equivalent. Label all containers and squeeze bottles with reagent ID, lot, and expiration date.
Water

Methanol – purge and trap reagent grade or equivalent

Blank sand

Sodium bisulfate

STANDARDS

All standards used must be pure material or from prepared certified solutions. The certificate of analysis shall be kept on file. Follow manufacturer's instruction for standard expiration and storage. Label all working standards using completed standard labels.

The following describes the standards used and their preparation:

1. All stock standards are received in glass sealed ampules.
   A. The following stock standards are used, as necessary to prepare solutions for calibration, CCV, LCS, and MS samples:
      A.1 Stock standard solutions – 1000mg/L (8260 mix)- Ultra Part# DWM-588 - commercially prepared certified solutions in methanol, stored at -15ºC ± 5ºC, until the documented manufacturer's expiration date.
      A.2 Stock standard solutions – 2000mg/L (ketone mix)- Ultra Part# CUS 12327 - commercially prepared certified solutions in 4:1 methanol/water, stored at -15ºC ± 5ºC until the documented manufacturer's expiration date.
      A.3 Stock standard – 2000 mg/L custom mix Ultra Part# CUS 12326 – commercially prepared certified solution in methanol, stored at -15ºC ± 5ºC, until the documented manufacturer's expiration date.
      A.4 Stock standard – Acrolein/Acrylonitrile (A–2000 mg/L; Vinyl Acetate – 400 mg/L) (AAV) NSI Part# Q2143 – commercially prepared certified solution in water, stored at 4ºC ± 2ºC, until the documented manufacturer's expiration date.
      A.5 Stock standard – 2-Chloroethyl vinyl ether (CVE)NSI Part# 17-04-15 – 1000 mg/L - commercially prepared certified solutions in methanol, stored at -15ºC ± 5ºC, until the documented manufacturer's expiration date.
      A.6 Stock standard – Appendix IX compounds – 2 mixes – 2500/200 mg/L Ultra Part# CUS 12032 and CUS 11407 – commercially prepared certified solutions in methanol, stored at -15ºC ± 5ºC, until the documented manufacturer's expiration date.
      A.7 Stock standard solutions – oxygenate mix (4 mixes – Ultra Part# CUS 11575, CUS 11651, CUS 11389, CUS 11390 - commercially prepared certified solutions in methanol, stored at -15ºC ± 5ºC, until the documented manufacturer's expiration date.
      A.8 Additional standards may be run that are project specific. All standards shall be certified and stored according to the manufacturer's instructions.

   B. Independent stock standards – standard mixes identical to those listed above from a secondary source or a secondary lot number from the same manufacturer. These standards are used to prepare the ICVs.

   C. Stock IS/SS mix – 5000 mg/L – Ultra Part# STM-541-1 – commercially prepared certified solution in methanol, stored at -15ºC ± 5ºC, until the documented manufacturer's expiration date. This solution is also used to prepare BFB tune check solution.

2. Secondary standards – Secondary standards are prepared by diluting the stock standard as described below. The first three standards listed in Table 1 and labeled 8260 are prepared together then transferred to 2mL ampule vials with minimum headspace and stored at $-15^{o}C \pm 5^{o}C$. These standards may be stored for up to 14 days. However, please note that for the individual vials, they should not be used for more than 7 days once opened. All other secondary standards are prepared as listed in Table 1, and then transferred to 2mL ampule vials with minimum headspace and stored at $-15^{o}C \pm 5^{o}C$. These standards may be stored for up to 6 months or until the manufactures expiration, whichever is sooner. Procedure for Volatile standard preparation:

   A. Assemble the necessary glassware, syringes and solvent. Purge and trap reagent grade methanol shall be used for all VOA standard preparation.

   B. Ensure that all glassware and syringes are clean and free of moisture by rinsing with at least three aliquots of methanol. Volumetric glassware should never be stored in or placed in heated ovens. The use of dedicated glass will help prevent cross-contamination of standards.

   C. Fill the volumetric glassware to volume with Methanol. Remove the appropriate amount of Methanol that will be replaced by the standard volume. Addition of standards shall proceed by adding the more highly volatile compounds last to prevent compound loss.

   D. Add the proper volume of standards using a syringe. Minimum agitation should occur upon adding the standard solution.

   E. After the addition of standard, the volumetric flask should be diluted until the meniscus reaches the calibration mark.

   F. Insert the glass stopper and mix by inverting three times.

   G. Cool the flask and its contents to approximately $5^{o}C$.

   H. Using a Pasteur pipette, transfer the standard to a 2 mL ampule. Seal the ampule immediately.

   I. Standards may be stored in mininert vials with minimal headspace.

   J. Label the vial with the following information:

      Standard Name
      Standard ID #
      Initials of Person Preparing Sample
      Date of Preparation
      Expiration Date

K. Store the vial the same as the stock standard.

L. Dispose of excess materials in accordance with established laboratory procedures.

M. Always quantitate new standards against known standards to ensure accurate concentration levels.

N. Fill out the standards logbook in accordance with proper laboratory.

O. A combined solution containing the internal standards and surrogates is prepared as the secondary standard. IS/SS is added automatically by the Solatek autosampler.

O.1 Internal standards - The recommended internal standards are Fluorobenzene, Chlorobenzene-d5, and 1,4-Dichlorobenzene-d4. Each calibration standard, blank, LCS, and sample undergoing GC/MS analysis must be spiked with 50 ug/L of the internal standard spiking solution prior to analysis. Different internal standards may be used as necessary.

O.2 Surrogate standards – The recommended surrogates are Toluene d-8, Bromofluorobenzene, 1,2 – Dichloroethane-d4, and Dibromofluoromethane. Each, blank, LCS, and sample undergoing GC/MS analysis should be spiked with 50 ug/L of the surrogate spiking solution prior to analysis. Different surrogate standards may be used as necessary.

Table 1
Secondary Standards

	Stock Conc.	Initial Vol.	Final Vol.	Final Conc.	Solvent
8260 mix	2000 mg/L	1.25 mL	10 mL	250 mg/L	Methanol
8260 custom	2000 mg/L	1.25 mL	10 mL	250 mg/L	Methanol
8260 Ketones	2000 mg/L	1.25 mL	10 mL	250 mg/L	Methanol
CVE	1000 mg/L	2.5 mL	10 mL	250 mg/L	Methanol
AAV	2000/400 mg/L	1.25 mL	10 mL	250/50 mg/L	Deionized water
APP IX Mix 1	2500 mg/L	1.0 mL	10 mL	250 mg/L	Methanol

	Stock Conc.	Initial Vol.	Final Vol.	Final Conc.	Solvent
APP IX Mix 2	various	2.5 mL	10 mL	various	Methanol
Oxygenate Mix 1	2000 mg/L	1.25 mL	10mL	250 mg/L	Methanol
Ethanol	250,000 mg/L	2.0 mL	10 mL	50,000 mg/L	Methanol
3,3-Dimethylebutanol	25,000 mg/L	2.0 mL	10 mL	5,000 mg/L	Methanol
IS/SS	5000 mg/L	2.5 mL	250 mL	50 mg/L	Methanol

3. The following working standards are prepared from the secondary standards and diluted in reagent water:
   A. Calibration standards are prepared at a minimum of five concentrations for all target compounds and surrogates (additional concentrations may be analyzed) from the secondary dilution of stock standards. Prepare these standards in deionized water. The calibration standards are prepared immediately before use at concentrations of 5, 20, 50, 100, and 200 ug/L for solids and waters using a 5mL purge. For waters using a 25mL purge prepare the standards at concentrations of 1, 2, 5, 10, and 25 ug/L. Each standard is prepared in a volumetric flask or a 5ml gas tight syringe. Lower concentration standards may be required to meet project requirements. The 8260 mix, ketones, gases, CVE, AAV, and surrogate standards (250 ug/L) are combined. The three APP IX mixes are also combined and are calibrated separately. Analysis of analytes not contained in any of the aforementioned standards may be calibrated for in combination with the 8260 mix, ketones, gases, CVE, and AAV if sufficient resolution is achieved, or may be calibrated for separately. 44mL of each standard is transferred to a 44mL VOA vial for water calibrations performed using the Solatek 72 autosampler. 5mL of each standard is transferred to a 44mL low bleed septa vial for solid calibrations.

   B. Initial calibration verification standard – Prepare a 50 ug/L standard from the secondary dilution of the independent stock standard (250/50 mg/L). The mixes are combined in the same manner as the calibration standards.

   C. LCS and Matrix Spiking Standards – spike at a concentration of 10 ug/L (25 mL purge) and 50 ug/L (5 mL purge and solids) using the working standards. For South Carolina, DOD, and AFCEE project, the LCS must be spiked with all target analytes.

RECOMMENDED CONDITIONS

The following lists conditions that may be used in the lab.
The analyst is allowed to modify settings to optimize operating conditions.

GC Instrument Conditions
Oven Temperature: 35°C
Rate A: 25°C/min to 180°C
Rate B: 45°C/min to 245°C
Hold: 2.26 min
Carrier Gas - Helium

Purge & Trap Conditions
Purge: 11 minutes at 30°C
Desorb Preheat: 205°C
Desorb: 1.5 minutes at 250°C
Bake: 6.5 minutes at 260°C

CHEMSTATION PROCEDURE

Due to shift overlaps which creates the probability that more than one analyst will be accessing a given instrument during a 12-hour tune sample batch, GCAL utilizes a master username and password to access Chemstation software. The password expires every 30 days and access to the passwords is granted by the GCMSV supervisor.

To Log In to Chemstation:

1. Enter “gcmsv” for the user name.
2. Obtain password from the GCMSV supervisor and enter the password when prompted by the Chemstation software.

To Change a Password

1. When a current password has expired, Windows prompts the user to enter current credentials including user name and password.
2. Once this information has been entered, the user is then notified that the password has expired and must be changed.
3. Enter a new password into the software when prompted, confirm the new password, and notify the GCMSV supervisor of the password change.

Chemstation Use

1. Chemstation use is limited to those employees who have been given password access by the GCMSV supervisor and are involved in the process of data production in the GCMSV laboratory. New employees are not granted password access until the GCMSV supervisor is satisfied that the

employee has been properly trained on its use. All employees listed on current organizational chart maintained by the QA/QC department are eligible for password access if granted by the GCMSV supervisor.

2. To create an audit trail, each line in the sequencing file represents a unique sample injection. The analyst that is programming the Chemstation and loading a particular sample must include their initials in the miscellaneous information field as part of the sample sequence. This information is then transferred to Target which is used for all data acquisition. Sequence files must be saved by analytical batch and include the date in the name. On days when multiple batches are performed, letters should be added to the data to denote different analytical batches. The format for individual sample sequencing is as follows:

TYPE	Vial	Data File	Method	Sample Name
“Sample”	Autosampler Position	Unique sequential ascending number	“8260”	GCAL sample number

Miscellaneous Information
GCAL Batch Number*Dilution Factor*Analyst Initials

* Please note, only the vial, datafile, sample name, and miscellaneous information fields are edited when programming sequences. Type and method fields always remain the same for each sequence file.

PROCEDURE

1. Procedures for instrument tuning

A. The instrument should be tuned using FC-43 (perfluorotributylamine) such that all tuning criteria for BFB can be met (Table 2). Before analysis begins, each instrument must be tuned checked by direct injecting 2 uL of a solution containing 25 mg/L BFB or by purging an amount equivalent to 50ng of BFB standard.

B. The mass spectrum of 4-Bromoflurorobenzene (BFB) is acquired by using the average of three scans: the peak apex scan and the scans immediately preceding and following the apex. Background subtraction is required using a single scan no more than 20 scans prior to the elution of BFB. The tune method is hard coded to perform the above functions and is checked manually if BFB tune criteria fails.

C. The BFB tuning criteria in Table 2 must be met before proceeding with analysis. If these criteria cannot be met, the instrument should be manually tuned with FC-43. If tune criteria is still not met instrument maintenance is performed.

D. Once the BFB tune criteria have been met, the instrument is considered to be tuned for a twelve-hour period starting from the injection time of the BFB.

E. The instrument must be retuned before the twelve-hour period has elapsed if any major adjustments are made to the mass spectrometer that may affect the tuning criteria.

Table 2
BFB ACCEPTANCE CRITERIA

M/Z	ION ABUNDANCE CRITERIA
50	15 - 40% OF MASS 95
75	30 - 60% OF MASS 95
95	BASE PEAK, 100% RELATIVE ABUNDANCE
96	5 – 9% OF MASS 95
173	LESS THAN 2% OF MASS 174
174	50 - 120 OF MASS 95
175	5 – 9% OF MASS 174
176	>95 BUT <101% OF MASS 174
177	5 – 9% OF MASS 176

2. Procedures for initial calibration

A. The initial calibration standards are prepared at a minimum of five different concentrations from the secondary dilution. Additional standards are usually included for specific compounds including a 0.2ppb, 0.4ppb, 1ppb, 2ppb, and 10ppb.

The calibration range is defined as the on-column concentration range.

1. At least five contiguous points must be used (six if a quadratic curve fit is employed).
2. Calibration acceptance criteria must be met as described below.
3. The lowest calibration point must support the lowest reporting limit needed in the associated samples.
4. The QC spike amount must be within the calibration range.

B. The standards are analyzed in the following sequence:

B.1. BFB (50 NG)
B.2. 5 PPB initial calibration
B.3. 20 PPB initial calibration
B.4. 50 PPB initial calibration
B.5. 100 PPB initial calibration
B.6. 200 PPB initial calibration

Note: These are the routine concentrations analyzed. In all cases the standards shall be run from lowest concentration to highest, or a blank shall be run following a high concentration standard (standards greater than 50 ppb) to establish a contaminant free instrument.

C. Once the five levels of standards have been analyzed, the validity of the initial calibration must be verified by comparing the SPCCs and CCC's to the following criteria.

C.1. Calibration check compounds (CCC) listed below must be ≤ 30 % RSD.

CCC's	% RSD
1,1-Dichloroethene	<30%
Chloroform	<30%
1,2-Dichloropropane	<30%
Toluene	<30%
Ethylbenzene	<30%
Vinyl Chloride	<30%

C.2. System Performance Check Compounds (SPCC) must have a minimum (RF) as indicated. All SPCC's must be evaluated at each level of the calibration curve to insure that compound instability and degradation are checked as required by the method.

SPCC's	MINIMUM RF
Chloromethane	0.1
1,1-Dichloroethane	0.1
Bromoform	0.1
1,1,2,2-Tetrachloroethane	0.3
Chlorobenzene	0.3

D. Additionally one of the following options must meet criteria. The analyst will judge criteria in the order given or with prior knowledge of the behavior of target compounds. One of the following must pass before a calibration is considered acceptable:

D.1 All target analytes have an RSD less than 15%.

D.2 A first order least square regression may be used if $r^2 \geq 0.995$. The curve shall not be forced through zero. The analyst should check the y-intercept (b). If the intercept is greater than half the reporting limit, this option cannot be used.

D.3 A quadratic curve fit is used with the coefficient of determination $r^2 \geq 0.990$. A minimum of a six-point calibration is used if this option is chosen and the curve shall not be forced through zero. The analyst should check the y-intercept (b). If the intercept is greater than half the reporting limit, this option cannot be used. The quadratic calibration option is not allowed for South Carolina projects.

D.4 Alternatively, if the analyte is listed as a poor performer and does not meet the criteria listed above, the data may be reported with a narrative if authorized by the client. NOTE: Compounds cannot be classified as poor performers for South Carolina projects.

D.5. If a CCC compound is a target analyte, then it must exhibit and average %RSD of <15%. If the average %RSD is >15% but <30%, it may be evaluated using a linear or quadratic curve fit.

E. If the initial calibration does not conform to the above listed criteria, corrective action must be taken.

F. The position of the retention time should be set using the mid-point of an initial calibration, and must be checked and reset as necessary after source cleaning or column maintenance.

3. Initial Calibration Verification

A. Immediately following the initial calibration procedure or before sample analysis, the analyst shall perform initial calibration verification (ICV). This will consist of a solution containing all target analytes prepared from a standard that is independent (second source) from the standards used for the initial calibration.

B. The ICV must be analyzed following the initial calibration. The ICV must exhibit a recovery of 70-130%, except for the targets listed in Table 3, which must be recovered between 60-140%. Recovery requirements may differ on a project specific basis. See SOP GEN-019. All analytes must exhibit a recovery of 70-130% for South Carolina samples.

C. If any target analyte recovery is outside the control limits, corrective action must be taken (project specific exceptions may apply). This may include instrument maintenance, re-analysis of the ICV or initial calibration, or re-preparation of the standards involved. If the target fails high and is not present in the associated samples, the data may be reported with a narrative.

4. Procedures for Continuing Calibration

A. The 50 PPB continuing calibration is analyzed in each batch after acceptable BFB tune and before samples. The following criteria shall be achieved before sample analysis:

A.1 CCC's must meet the specified criteria for all target analytes. Calibration Check Compounds (CCC's) are allowed no greater than 20% difference from the initial calibration if calibration option 2.D.1 or 2.D.4 is used or % drift ≤20% if a linear or quadratic calibration option was used. The quadratic calibration option is not allowed for South Carolina projects.

A.2 System performance-check compounds (SPCC's) are required to maintain a relative response factor (RF) as indicated in 2C.2.

A.3 All target analytes should have a %Difference ≤ 20% from the initial calibration if calibration options 2.D.1 or 2.D.4 were used or %Drift ≤20% of expected value if a linear or quadratic calibration option was used. All targets must have difference/drift ≤ 30%. Project specific limits may apply and are listed in the LIMS. The quadratic calibration option is not allowed for South Carolina projects.

NOTE: For Exxon samples any %differences/drift that exceed 20% for target analytes but meet the 30% in house criteria, should be narrated in the final report.

A.4 Some compounds have been classified as poor performers due to poor purging efficiency. These analytes are listed in Table 3 and are acceptable at ≤40% difference/drift. Poor performer exceptions are not allowed for South Carolina samples.

Table 3
Targets that exhibit poor purging efficiency

Acetone	Ethyl acetate
Acetonitrile	2-Hexanone
Acrolein	Isobutyl alcohol
Acrylonitrile	Methacrylonitrile
2-Butanone	4-methyl-2-pentanone
t-Butyl alcohol	Pentachloroethane
1,2-Dibromo-3chloropropane	Propionitrile
1,4-Dichloro-2-butene	Benzal chloride
1,4-Dioxane	1-Nitropropene
2-Chloropropene	1,3 Butadiene
Isopropyl ether	Tetrahydrofuran
2-Nitropropane	2,2,4-Trimethylpentane
2-Chloroethylvinyl ether	Ethyl ether
2-Butanol	Ethyl methacrylate
Cyclohexanone	Dicyclopentadiene
3-Dichloro-1-propene	n-Butanol
Allyl chloride	Methyl methacrylate
Chloroprene	Dichlorodifluoromethane
Bromomethane	TBA
3,3-Dimethylbutanol	t-Amyl Alcohol
Ethanol	Ethyl tertbutyl ether
tert amylmethyl ether	Tertbutyl formate

A.5 If the target analyte (not a CCC) has failed, the RF has increased, and there are no hits during sample analysis, the data is reportable with a narrative. Note: no failures are allowed for South Carolina projects.

A.6 The retention time for any internal standard shall not vary any more than 30 seconds from the mid- point standard of the most recent initial calibration.

A.7 The internal standard area must not deviate by more than a factor of two (-50% to + 100%) from the mid-point standard of the most recent initial calibration.

A.8 Project specific criteria may apply and may be more stringent. See SOP GEN-019.

B. If specified criteria are not met, corrective action must be taken. If no source of the problem can be determined after corrective action has been taken, a new initial calibration must be generated.

5. The purpose of the method blank is to ensure that the analytical system is free of contamination and carryover. The method blank is run at least once per batch (not to exceed 20 samples) before sample analysis. The method blank shall be handled in exactly the same manner as the samples that it represents.

A. The following are a description of the three types of method blanks commonly used in routine analysis and the analysis and evaluation of storage blanks.

A.1 Water - Water blanks require no special preparation. Fill a VOA vial with reagent water. Place the full 44 mL VOA vial on the SOLATek autosampler. 5 uL of the internal standard/surrogate standard will be added automatically.

A.2 Low-level soil – Low-level soil method blanks require special preparation techniques. Place the 5.0 grams of sand in a 44 mL vial and add 5.0 mL of deionized water. Place on the autosampler. The SOLATek will add 5.0 mL of deionized water and the internal/surrogate standards.

A.3 Medium/High level soil – medium/high level soil blanks are prepared by weighing 5.0 grams of sand into a 44 ml VOA vial. Add 5.0 ml Methanol. Shake the vial to extract any volatiles into the solvent. A 1000 uL extract aliquot is diluted to 50ml in a volumetric flask with deionized water. Place on the autosampler. The autosampler will add an amount of internal standard/ surrogate solution equivalent to 50ug/L. Document preparation of blank in logbook.

A.4 Storage Blanks – A set of at least two storage blanks filled with reagent water are kept in each cooler used to store samples. Storage blanks are analyzed every two weeks. If there is detection above ½ the reporting limit, analyze the second vial to confirm the detection. If the results are confirmed immediately notify QA of the affected blank, cooler tested, and storage time. All data must be filed in the appropriate logbook.

B. To prove a contaminant free system, no target analytes shall be detected in the method blank above one half the reporting limit except for common laboratory contaminants, which shall be less than the reporting limit. If any target analytes are detected above this level, data shall not be reported and samples must be re-extracted and re-analyzed unless the following apply:
   - B.1 If a target analyte is detected above the reporting limit, data may be reported if the concentration is not greater than 10% of the measured concentration in associated samples. Include a narrative with the data.
   - B.2 If a target analyte is detected in the method blank but there are no hits in the samples, the data may be reported with a narrative.
   - B.3 If re-analysis is not possible, flag the associated samples and include a narrative in the report. Document the action taken.

C. The source of blank contamination shall be investigated and measures taken to eliminate future contamination.

D. Project specific criteria may apply and may be more stringent. See SOP GEN-019.

6. Procedure for Laboratory Control Spike (LCS/LCSD). An LCS and LCSD are included in each batch of up to 20 samples to demonstrate the system is in control. An LCSD is not required if an MS/MSD is performed. Routinely the LCS/LCSD will be spiked with the full list of 8260 analytes at 50ug/L. The CCV performed that day may be used as the LCS if allowed by the project. Check with the project manager for project specific spiking criteria; some projects may require all target analytes are spiked. The LCS is assessed using the following criteria:

NOTE: For all sample batches involving Exxon samples, the LCS/LCSD pair analysis must be independent of the CCV analysis.

A. The percent recovery is calculated for all analytes spiked (see Calculation section). Recoveries are compared to the appropriate control limits. In-house control limits are used if project specific limits have not been requested, and are available in the LIMS. Project specific control limits may be requested; check with the project manager for limits needed. For South Carolina samples, all analytes must be recovered at 70-130% of the expected value.

B. If a recovery is above the upper control limit and the sample results are below the reporting limit, the data may be reported with a narrative. All analytes must pass for South Carolina samples.

C. If a recovery is below the lower control limit, the batch must be re-analyzed unless it meets the requirements of a sporadic failure (see below). If a re-extraction is not possible due to insufficient sample volume, report the data with a narrative. All analytes must pass for South Carolina samples.

D. If the full list of target analytes is spiked, a small number of sporadic failures will be allowed. The failure cannot include a primary compound of interest as defined by the client. See Table 4 for the number of allowable failures. The failures are noted in the case narrative. These failures shall be monitored to ensure randomness. This shall be defined as not exceeding failure in 1 of 3 LCS determinations. If the same analyte fails repeatedly and is not included in Table 3, locate the source of the problem and perform corrective action. All analytes must pass for South Carolina samples.

Table 4
Number of Allowable Failures

Number of Analytes	Failures Allowed
<11	0
11-30	1
31-50	2
51-70	3
71-90	4
>90	5

E. If an LCS and an LCSD are analyzed, calculate precision using the RPD in the Calculation section, equation 2. Substitute the LCS and LCSD results for the MS/MSD. Precision is assessed using the criteria in the LIMS.

7. Procedures for Matrix Spikes
   A. Analyze one matrix spike/matrix spike duplicate (MS/MSD) pair with each batch of up to 20 samples processed together. The purpose of the spikes is to confirm the matrix being analyzed is not interfering with the recovery of the analytes.

   B. The MS/MSD spike includes the full 8260 list of analytes; the spiking level is 50 ug/L. Check with the project manager for project specific spiking criteria; some projects may require all target analytes are spiked.

   C. Calculate % recovery for all compounds using Calculations equations 1 and 2. All compounds are evaluated to determine acceptance of the

MS/MSD. Acceptance criteria for MS/MSD are located in Appendix B of this SOP.

D. Whenever the MS and/or MSD recoveries are outside the control limits, check the LCS and LCSD to verify the system was in control, and include this in the case narrative.

E. Precision is calculated as %RPD. Acceptance criteria are listed in the LIMS. Failures are noted in the narrative.

F. Review data to verify that a lab error has not occurred (wrong spike amount, not spiked) before automatically identifying a failure as matrix interference.

G. If recoveries for both the MS/MSD are outside the control limits and the recoveries are similar, the data is reportable with a narrative stating the LCS recoveries were acceptable. The failure is attributed to sample matrix.

H. Native sample concentrations may be high in comparison to the spiking concentration and therefore an accurate recovery cannot be calculated. Document this in the case narrative. Additionally, soil weights may vary significantly for some MS/MSD pairs and will affect the RPD calculation.

8. QC and Sample Preparation:

A. Aqueous sample - place the full 44 mL VOA vial on the SOLATek autosampler. 5 uL of the internal standard/surrogate standard will be added automatically. All dilutions must be prepared using volumetric flasks or performed by the autosampler. To prepare MB and LCS/LCSD samples use reagent water.

B. Low-level soil – SOLATek autosampler is used, place the 5.0 grams of sample in a 44 mL vial and add 5.0 mL of reagent water. Place on the autosampler. The SOLATek will add 5.0 mL of reagent water and the internal/surrogate standards. To prepare LCS/LCSD samples use blank sand.

C. Medium/High level soil and Concentrated Waste – medium/high level soil and concentrated waste samples are prepared by weighing 5.0 grams of sample into a 44 ml VOA vial. Add 5.0 ml Methanol. Shake the vial to extract the volatiles into the solvent. A 1000 uL extract aliquot is diluted into a 50ml volumetric flask containing deionized water. The contents are then transferred to a 44ml VOA vial. The SOLATEK autosampler will add the internal standard/surrogate solution to yield a concentration of 50ug/L. To prepare LCS/LCSD samples use reagent water.

D. EnCore™ sampler (En Chem, Inc)
   D.1 Preservation – A 200g/L sodium bisulfate solution is prepared by weighing 200g of sodium bisulfate and bringing this to volume with deionized water, in a 1L volumetric flask. 5mL of this solution is added to a VOA vial and a magnetic stirring bar. Record the lot # of the sodium bisulfate solution in the sample prep logbook. Tare the balance. Dispense the contents of the EnCore™ sampler into the vial and record the weight of the sample.
   D.2 Load the vial onto the SOLATek autosampler. The autosampler will add 5 mL of deionized water containing the internal standard and surrogate standard.

9. Sample Analysis:
   A. Samples may be screened by GCAL.
      A.1 Reasons for screening may include but are not limited to the following:
         A.1.1 Inconsistent historical data
         A.1.2 Physical appearance of the sample
         A.1.3 Client notification of suspected high concentration of VOC's
         A.1.4 No historical data

      A.2 Samples that are deemed necessary for screening must have adequate volume for the screening process and the subsequent volume for the reportable analysis.

      A.3 Screening data is not reportable, as the screening analysis is performed on an instrument that has not met acceptable criteria for reportable analysis. The screening data may be provided upon client request, if applicable.

      A.4 The screening process is performed in an attempt to prevent contamination of instrumentation performing reportable analysis, thus reducing the possibility of carryover contamination from samples containing high levels of VOC's and resulting in instrument down time.

      A.5 Screening analyses are typically performed at a dilution factor in the range of 20 to 1000. Dilution factors may be performed outside of this range. Screening dilutions may be determined by, but are not limited to the following:
         A.5.1 Client notification of suspected high concentrations of VOC's
         A.5.2 Physical appearance of the sample

A.5.3 Historical data from similar projects

B. All samples are spiked with the following surrogates: 1,2-Dichloroethane-d4, Toluene-d8, Dibromofluoromethane, and Bromofluorobenzene

B.1 All surrogates recoveries must be within the ranges as listed in Table 5 below.

B.2 If any surrogate is below QC limits and target analytes are present, then the sample must be reanalyzed. If the same surrogate still fails in the same manner, then matrix interference is indicated and is included in the case narrative.

B.3 If the recoveries for surrogates are above the upper control limits and no target analytes are detected, the sample is reported with a case narrative indicating surrogate recovery above control limits.

B.3 Control limits are updated annually. Project specific control limits and corrective action may apply and may be more stringent. See SOP GEN-019. All project specific limits shall be in the LIMS.

Table 5

Surrogate	Water Recovery Limits	Solid Recovery Limits
1,2-Dichloroethane-d4	71-127	62-125
4-Bromofluorobenzene	78-130	62-127
Dibromofluoromethane	77-127	65-130
Toluene-d8	76-134	71-132

C. Internal Standards (IS) - All samples are spiked with Fluorobenzene, Chlorobenzene-d5, and 1,4-Dichlorobenzene-d4.

C.1 The Internal Standard area for any internal standard must not deviate by more than (-50% to + 100%) from the daily CCV.

C.2 The retention time of the IS in the sample must not shift greater than $\pm$ 0.5 min of the retention time of the corresponding IS in the CCV.

C.3 If the sample fails any of the IS criteria it must be reanalyzed at the same dilution. If it is apparent that the IS is outside criteria due to interference from sample matrix, then contact the client to determine a course of action.

C.4 Project specific criteria may apply and may be more stringent. DOD and AFCEE projects require the internal standard response drift be evaluated using the most recent ICAL mid-point with control limits of –50 to +100%.

D. All dilutions are prepared in volumetric flasks or by using the dilution feature on the autosampler. Dilute samples so that the on-column amount is approximately in the mid-range of the calibration curve.

E. Load samples onto Solatek 72 autosampler. Sample sequences should be saved for future review, if needed.

F. Targets are qualitatively identified based on the retention time and on comparison of the analytes mass spectrum with a reference mass spectrum. A reference mass spectrum is generated using the same conditions of the method. In the reference mass spectrum three characteristic ions are identified, one of which is the primary characteristic ion. If there are not three ions, than any ion over 30% relative intensity may be used. The target is said to be present when the following criteria are met:
   - F.1 The intensities of the characteristic ion(s) maximize within one scan.
   - F.2 The RRT is within ±0.06 RRT units of the RRT of the standard.
   - F.3 The relative intensities of the characteristic ion(s) agree within 30% of the relative intensities of these ions in the reference spectrum.
   - F.4 Structural isomers may be identified as individual isomers if the height of the valley between them is less than 25% of the sum of the two peak heights.

G. Samples are quantitated once a positive identification has been made. The quantitation will be based on the area of the primary characteristic ion's EICP and the associated internal standard. Calculations are described in the calculation section. The quantitation ion used shall be the ion listed in the reference method(s) unless there are interferences. Qualifier ions shall be used as a replacement, if possible. If the quantitation ion used is not the ion listed in the reference method, this shall be documented and the documentation stored in the lab.

H. TICS may be reported if requested by manually entering data into the LIMS. If no TICS were found, and the client requested a TIC search, this shall be noted in LIMS. A data system library search is used for identification, and the concentration is estimated using an RF of 1 and the area and concentration of the internal standard with the closest retention time.

I. Manual integrations shall be performed as appropriate. The supervisor reviews manual integrations and the raw data is flagged. For additional information see SOP QA-010.

CALCULATIONS

1. $$\text{MS \% REC} = \frac{\text{MS Concentration-Sample Concentration}}{\text{spike added}} \times 100$$

2. MSD % REC = MSD Concentration-Sample Concentration x 100

spike added

3. $\% \text{ RPD} = \dfrac{\text{MS-MSD}}{\dfrac{\text{MS + MSD}}{2}} \times 100$

4. $\text{Response Factor} = \dfrac{A_s \times C_{is}}{A_{is} \times C_s}$

As = Peak Area of analyte or surrogate
Ais = Peak Area of Internal standard
Cs = Concentration of the analyte or surrogate
Cis = Concentration of Internal standard

5. $\%\text{Recovery} = \dfrac{\text{Concentration Found}}{\text{Concentration Added}} \times 100$

6. Concentration using RF:

$$\text{Concentration } (\mu g/L) = \frac{(A_s)(C_{is})(D)}{(A_{is})(RF)(1000)}$$

$$\text{Concentration } (mg/kg) = \frac{(A_s)(Cis)(D)}{(A_{is})(RF)(W_s)(1000)}$$

A_s = Area of peak for the analyte in sample
D = Dilution factor
RF = Mean Response factor from initial calibration (area/ng)
A_{is} = Area of internal standard in sample
C_{is} = Concentration of internal standard
W_s = Weight of sample

7. Concentration using linear curve fit:

$$\text{Concentration } (\mu g/L) = [m(A_S/A_{IS})+b]C_{IS}D$$

$$\text{Concentration } (mg/kg) = [m(A_S/A_{IS})+b]C_{IS}D(5/W_S)$$

m = Inverse of slope
A_s = Area of peak for the analyte in sample
A_{is} = Area of internal standard in sample
b = Intercept of the y-axis
C_{is} = Concentration of internal standard
D = Dilution factor
W_s = Weight of sample

8. For quadratic curve fit see Target3 Data Analysis Software Reference Guide page 3-17. The quadratic calibration option cannot be used for South Carolina projects.

9. Concentration of TICS:

$$\text{Concentration (mg/kg)} = \frac{(A_s)(C_{is})(D)}{(A_{is})(1000)}$$

A_s = Area of peak for the analyte in sample
D = Dilution factor
A_{is} = Area of internal standard in sample
C_{is} = Concentration of internal standard
W_s = Weight of sample (if aqueous sample W_s = 1 and report in (µg/L)

10. Calculations for various hydrocarbon ranges. See Appendix B

11. % Difference = $[(RF_I - RF_C) / RF_I\}\ 100$

RF_I = Average response factor from initial calibration
RF_C = Response factor from current verification check standard

12. % Drift = $\frac{|\text{Measured Conc} - \text{Spike Conc}|}{\text{Spike Conc}} * 100$

13. % RSD = (SD / X) 100

RSD = Relative Standard Deviation
X = mean of 5 initial RF's for a compound
SD = Standard Deviation of average RF's for a compound

REPORTING LIMIT Samples analyzed by Method 8260B have a routine reporting limit of 5 ppb for all analytes of interest with the exception of the following compounds:

Acetone – 25 ppb
Acetonitrile – 100 ppb
Acrolein – 25 ppb
Acrylonitrile – 25 ppb
1,4-Dioxane – 200 ppb
Isobutanol – 100 ppb
Methyl Ethyl Ketone – 25 ppb
Methyl Methacrylate – 100 ppb
Propionitrile – 100 ppb
Methylene Chloride – 10 ppb
Benzal Chloride – 20 ppb
n-Butyl Alcohol – 100 ppb
Ethyl Acetate – 100 ppb
Ethyl Ether – 100 ppb

Cyclohexanone – 100 ppb
Cyclohexane – 100 ppb
1,3-Butadiene – 10ppb
1,3-Dichloropropene – 10 ppb
1-nitropropane – 10 ppb
2-methyltetrahydrofuran – 20 ppb
2-methyltetrahydropyran – 10 ppb
2-nitropropane – 20
2-H-tetrahydropyran – 20 ppb
Allyl Chloride – 25 ppb
Chloroprene – 80 ppb
Cumene hydroperoxide – 20 ppb
Ethylene oxide – 100 ppb
Tetrahydrofuran – 100 ppb
Sec-Butanol – 10 ppb
t-Butanol – 10 ppb

Lower limits may be achieved for specific projects. Reporting limits are achieved by running a low level standard at the same level as the reporting limit. The RL should be at least 2X the MDL. Specific project criteria may apply. See SOP GEN-019.

DATA REVEIW

For data review procedures and checklist, please see SOP QA-002.

SOFTWARE TROUBLESHOOTING

The Tekmar Solatek 72 instruments utilize Tekmar software VOC TEKLINK Version 2.4.4647 to control the autosampler and purge and trap function. The Agilent GC/MS's utilize Agilent software MSD Chemstation Version D.02.00.275 to control the instrument and transfer data acquisition to Target Data Integration software. Target software is utilized to calculate all data. In the event of software malfunction for the Tekmar Solatek 72, please contact Tekmar technical support for troubleshooting help. In the event of software malfunction for the GC/MS, please contact Agilent technical support for troubleshooting help. In the event of software malfunction when using Target, please contact GCAL's IT Director for troubleshooting help.

METHOD PERFORMANCE

1. The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

2. This method has been tested using purge-and-trap (Method 5030) in a single laboratory using spiked water. Using a wide-bore capillary column, water was spiked at concentrations between 0.5 and 10 ug/L. Single laboratory accuracy and precision data are presented for the method analytes in Table 6 of the 8260 method. Calculated MDLs are present in Table 1 of the 8260 method.

3. The method was tested using purge-and-trap (Method 5030) with water spiked at 0.1 to 0.5 ug/L and analyzed on a cryofocussed narrow-bore column. The accuracy and precision data for these compounds are presented in Table 7 of the 8260 method. MDL values were also calculated from these data and are presented in Table 2 of the 8260 method.

4. Single laboratory accuracy and precision data were obtained for the Method 5035 analytes in three soil matrices; sand; a soil collected 10 feet below the surface of a hazardous landfill, called C-Horizon; and a surface garden soil. Sample preparation was by Method 5035. Each sample was fortified with the analytes at a concentration of 4 ug/kg. These data are listed in Tables 17, 18, and 19 of the 8260 method. All data were calculated using fluorobenzene as the internal standard added to the soil sample prior to extraction. This causes some of the results to be greater than 100% recovery because the precision of results is sometimes as great as 28%.

5. In general, the recoveries of the analytes from the sand matrix are the highest, the C-Horizon soil results are somewhat less, and the surface garden soil recoveries are the lowest. This is due to the greater adsorptive capacity of the garden soil. This illustrates the necessity of analyzing matrix spike samples to assess the degree of matrix effects.

6. The recoveries of some of the gases, or very volatile compounds such as vinyl chloride, trichlorofluoromethane and 1,1-dichloroethene are somewhat greater than 100%. This is due to the difficulty encountered in fortifying the soil with these compounds, allowing an equilibration period, extracting them with a high degree of precision. Also, the garden soil results in Table 19 of the 8260 method include some extraordinary high recoveries for some aromatic compounds, such as toluene, xylenes, and trimethylbenzenes. This is due to contamination of the soil prior to sample collection, and to the fact that no background was subtracted.

POLLUTION PREVENTION

See QAPP Section 10.2

WASTE

MANAGEMENT See SOP GEN-009

Appendix A -8260 Analyte List

Acetone
Acetonitrile
Acrolein
Acrylonitrile
Benzene
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
2-Butanone (MEK)
n-Butylbenzene
sec-Butylbenzene
tert-Butylbenzene
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane
2-Chloroethylvinylether
Chloroform
Chloromethane
2-Chlorotoluene
4-Chlorotoluene
1,2-Dibromo-3-chloropropane
Dibromochloromethane
1,2-Dibromoethane
Dibromomethane
1,2 Dichlorobenzene
1,3 Dichlorobenzene
1,4 Dichlorobenzene
Dichlorodifluoromethane
1,1-Dichloroethane
1,2 Dichloroethane
1,1-Dichloroethene
cis-1,2-Dichloroethene
trans-1,2-Dichloroethene
1,2-Dichloropropane
1,3-Dichloropropane
2,2-Dichloropropane
1,1-Dichloropropene
cis-1,3-Dichloropropylene
trans-1,3-Dichloropropene
Ethylbenzene
2-Hexanone
Hexachlorobutadiene
Isopropylbenzene
p-Isopropyltoluene
Methylene Chloride
4-Methyl-2-pentanone
Methyl tert-butyl ether
Naphthalene
n-Propylbenzene
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethene
Toluene
1,2,3-Trichlorobenzene
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichlorofluoromethane
1,2,3-Trichloropropane
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Vinyl acetate
Vinyl chloride
m+p-Xylene
o-Xylene
Xylenes, total
1-Chlorohexane
DIPE
ETBE
TAME
tert-Butyl alcohol
1,2-Diethyl Benzene
1,3-Diethylbenzene
1,4-Diethylbenzene
Total Diethylbenzene

Appendix B

1. Calculations for Total Other VOC's

   The total ion chromatogram of a method 8260B gas chromatographic/mass spectrometric (GC/MS) analysis is integrated and peaks attributed to target analytes, internal standards, surrogates, and those compounds which may elute before Dichlorodifluoromethane and those compounds which may elute after 1,2,3-Trichlorobenzene are subtracted from the total peak area of the chromatogram. The total concentration of non-target volatile organic components is calculated and reported by relating the resultant ion peak area to the total ion peak area of an intern standard (Fluorobenzene) of known concentration (50ppb). An area report is loaded from the Samba server into the Filemaker program. After entering the minimum and maximum retention times (corresponding to the elution times of Dichlorodifluoromethane and 1,2,3-Trichlorobenzene, respectively) and the appropriate dilution factor, the area report is imported and results are generated.

2. Calculations for Other VOC's C6 and Lower

   The total ion chromatogram of a method 8260B gas chromatographic/mass spectrometric (GC/MS) analysis is integrated. A sum of all peak areas beginning with the elution of Dichlorodifluoromethane and ending with the elution of Hexane is generated. The total concentration of C6 components is calculated and reported by relating the resultant C6 area to the peak area of an internal standard (Fluorobenzene) of know concentration (50ppb). An area report is loaded from the Samba server into the Filemaker program. After entering the minimum and maximum retention times (corresponding with the elution times of Dichlorodifluoromethane and 1,2,3-Trichlorobenzene), the retention time for Hexane, and the appropriate dilution factor, the area report is imported and results are generated.

3. Calculations for Other VOC's C7 and Higher

   The total ion chromatogram of a method 8260B gas chromatographic/mass spectrometric (GC/MS) analysis is integrated. A sum of all peak areas beginning with the elution of Hexane and ending with the elution of 1,2,3-Trichlorobenzene is generated. The total concentration of C7 components is calculated and reported by relating the resultant C7 area to the peak area of an internal standard (Fluorobenzene) of know concentration (50ppb). An area report is loaded from the Samba server into the Filemaker program. After entering the minimum and maximum retention times (corresponding with the elution times of Dichlorodifluoromethane and 1,2,3-Trichlorobenzene), the retention time for Hexane, and the appropriate dilution factor, the area report is imported and results are generated.

Appendix C

Glossary

ACCEPTANCE LIMITS – data quality limits specified by the test method or generated by the laboratory. Specified limits placed on an item, process, or service defined in the requirement document.

ACCURACY – a measure of how close a measured value is to a known true value. Accuracy is assessed by means of reference samples and percent recoveries of spiked samples. The degree of agreement between an observed value and an accepted reference value. Accuracy includes combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

ALIQUOT – a discrete, measure, or representative portion of a sample taken for analysis.

ANALYTE – the chemical element or compound an analyst seeks to determine; the chemical element of interest.

ANALYTICAL BATCH – the basic unit for analytical quality control, defined as samples that are analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each batch should be of similar composition (e.g., groundwater, sludge, ash).

ANALYTICAL SAMPLE – any solution or media introduced into an instrument on which an analysis is performed, excluding instrument calibration, initial calibration verification, initial calibration blank, continuing calibration verification, and continuing calibration blank. The following are all analytical samples: undiluted and diluted samples (EPA and non-EPA), predigestion spike samples, duplicate samples, serial dilution samples, analytical spike samples, post digestion spike samples, interference check samples (ICS), CRDL standard for AA(CRA), CRDL standard for ICP(CRI), laboratory control sample(LCS), preparation blank(PB), and linear range analysis sample(LRS).

ANALYST – the designated individual who performs the “hands on” analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

AREA UNITS – a term used in gas chromatography that indicates the peak area of a compound exiting a chromatographic column. The size or area of the peak is proportional to the amount of analyte in the sample.

ATOMIC ABSORPTION (AA) – a technique for analyzing metal using an element-specific lamp that emits a characteristic light spectrum. A sample is heated in a flame or graphite furnace and the light beam is passed through it. When the sample absorbs light, an energy loss is detected and is translated into a concentration of metal in the sample. This technique detects one metal at a time.

AUDIT – a systematic check to determine the quality of some function or activity. Two basic types are performance audits and system audits. Perform audits involve a quantitative comparison of the laboratory's results to those of a proficiency sample containing known concentration of analytes. A system audit is a qualitative evaluation that normally consists of an onsite review of a lab's quality assurance system and physical facilities.

BACKGROUND CORRECTION – a technique usually employed relative to metals analysis, which compensates for variable background contribution to the instrument signal in the determination of trace elements.

BATCH – environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A batch is composed of a maximum of twenty environmental samples. A preparation batch is composed of environmental sample of the same matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) and/or those samples not requiring preparation, which are analyzed together as a group using the same calibration curve or factor. An analytical batch can include samples originating from various environmental matrices.

BIAS – the deviation of the mean of replicate analytical measurements from a reference analyte concentration. Relative bias is represented by analytical measurement mean minus the reference analyte concentration and the difference divided by the reference analyte concentration. See accuracy and precision.

4-BROMO-FLUOROBENZENE (BFB) – the compound used to check the tuning of the instrument, and is used as a surrogate compound spiked into every sample for volatile analysis. A compound utilized in EPA gas chromatography/mass spectrometry (GC/MS) volatile methods to establish mass spectral instrument performance.

BIOCHEMICAL OXYGEN DEMAND (BOD) – A measure of the amount of oxygen consumed in the biochemical processes that break down organic matter in water. A larger BOD value indicates a greater degree of organic pollution. A related term, BOD5, is the amount of dissolved oxygen consumed in five days.

BIOSEED – the bacterial culture used to inoculate a sample for testing.

BLANK – an artificial sample designed to monitor the introduction of artifacts into the measurement process. For aqueous samples, reagent water is used as a blank matrix. There are several types of blanks, which monitor a variety of processes:1.) *laboratory blank* is taken through sample preparation and analysis only. It is a test for contamination in sample preparation and analyses. 2.) *storage blank* is stored and analyzed with samples at the laboratory. It is a test for contamination in sample storage as well as sample preparation and analysis. 3.) *trip blank* is shipped to and from the field with the sample containers. It is not opened in the field and, therefore, provides a test for contamination from sample preservation, site conditions, and transport as well as sample storage, preparation, and analysis. It is most commonly used for volatile organics. 4.) *field blank* is opened in the field and tests for contamination from the atmosphere as well as those activities listed under the trip blank.

BNA – base, neutral and acid extractable compounds. The term base, neutral and acid refer to the pH condition of the sample undergoing extraction. Certain compounds extract more efficiently from water under acidic conditions. Such compounds are often referred to as "acid extractables."

CALIBRATE – to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device, or the correct value for each setting of a control knob. The levels of the applied calibration standard should bracket the range of planned or expect sample measurements.

CALIBRATION – The systematic determination of the relationship of the response of the measurement system to the concentration of the analyte of interest. Instrument calibration performed before any samples are analyzed is called the initial calibration. Subsequent checks on the instrument calibration performed throughout analysis are called continuing calibration verification.

CALIBRATION BLANK (CB) – a volume of reagent water in the same matrix as the calibration standards but without the analyte.

CALIBRATION CURVE – the graphical relationship between the known values, such as concentrations, of a series of calibration standards and their analytical response.

CALIBRATION METHOD – a defined technical procedure for performing a calibration.

CALIBRATION STANDARD – a certified material used to calibrate an instrument.

CERTIFIED REFERENCE MATERIAL (CRM) – reference material, one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30)

CONTINUING CALIBRATION VERIFICATION (CCV) – used to evaluate the performance of the instrument system with respect to a defined set of method criteria. The CCVs are used to verify instrument performance during analysis. The CCV shall be prepared from the same stock standard solution used to prepare the calibration curve.

CHAIN-OF-CUSTODY–Procedures and associated documents designed to trace the custody of a sample from the point of origin to final disposition, with the intent of legally demonstrating that custody remained intact and the tampering or substitutions were precluded.

CHEMICAL OXYGEN DEMAND (COD) – A measure of the oxygen required to oxidize all compounds in water, both organic and inorganic.

COMBINED STANDARD UNCERTAINTY – The standard uncertainty of the analytical measurement result that is the sum in quadrature (square-root-of-the-sum-of-the-squares) of the component standard uncertainties.

CORRECTIVE ACTION – the action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation to prevent reoccurrence.

COVERAGE FACTOR – the numerical factor used as a multiplier of the combined standard uncertainty to expand the uncertainty corresponding to a specific level of confidence. The Student's *t*-distribution is used for determining the coverage factor.

DEMONSTRATION OF CAPABILITY (DOC) – a procedure used to establish the ability of the analyst to generate acceptable accuracy.

DEIONIZED WATER (DI) – water from which the majority of ions have been removed. Water that is contaminant free and used in the laboratory, the resistivity should be ≤ 18 megaohms.

DISSOLVED METALS –- metallic elements determined on a water sample that has been passed through a 0.45-um filter.

DISSOLVED OXYGEN (DO) – the oxygen freely available in water, an indicator of water quality.

DISSOLVED SOLIDS – disintegrated organic and inorganic material contained in water. Excessive amounts make water unfit to drink or use in industrial processes.

DRY WEIGHT – the weight of a sample based on percent solids. The weight of a sample after drying in an oven at a specified temperature.

DUPLICATE MEASUREMENT – a duplicate measurement is a second measurement made on the same or identical sample of material to assist in the evaluation of measurement of variance.

DUPLICATE SAMPLE – two samples taken from the same population and carried through certain stages of sampling and testing. Duplicate sample include field co-located duplicate samples, field-split duplicate samples, and laboratory duplicate subsamples.

EXPANDED UNCERTAINTY – the quantity defining an interval enveloping the analytical measurement that captures a large fraction of the distribution of analyte concentrations that could be attributable to the quantity measured. The combined standard uncertainty is multiplied by the coverage factor to calculate the expanded uncertainty.

EXTERNAL STANDARDS – a method of quantifying chromatographic data in which standards of known concentration are analyzed prior to unknown samples. The chromatographic peak area (or height) of a sample component is compared to a calibration curve of a peak area constructed from the standard data for that component. This comparison allows the concentration of the component in the sample to be determined.

FECAL COLIFORM BACTERIA – bacteria found in mammals' intestinal tracts. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens.

FLAME IONIZATION DETECTOR (FID) – a gas chromatography detector in which the column effluent gas is mixed with hydrogen and burned in air or oxygen. The ions and electrons produced in the flame generate an electric current proportional to the amount of materials in the detector. The FID responds to nearly all organic compounds, but it does not respond to air and water, which makes it exceptionally suited to environmental analysis.

FLASHPOINT – the lowest temperature at which a flammable liquid gives off sufficient vapor to form an ignitable mixture with air near its surface or within a vessel. Combustion does not continue.

GAS CHROMATOGRAPHY (GC) – a technique for detecting organic compounds by using their physical and chemical properties to separate a mixture. The compounds are identified and quantified with various types of detectors as they exit the chromatograph. Selection of detectors is dependent on the particular compounds of interest.

GAS CHROMATOGRAPHY MASS SPECTROMETRY (GCMS) – a technique in which sample analytes are bombarded with electrons as they exit a gas chromatography column and are fragmented into characteristics ion patterns. The mass spectrometer is the detector. It can determine which fragments are present and therefore the identity of the compounds.

GLUCOSE GLUTAMIC ACID (GGA) – used as a laboratory control standard in BOD procedures.

GRAPHITE FURNACE – a technique used for the analysis of metals. An atomic absorption spectrophotometer heats the sample within a graphite tube using an electrical current. It is also commonly called a flameless furnace and generally provides greater sensitivity for certain metals than flame or inductively coupled argon plasma techniques.

GRAVIMETRIC - analyses based on the direct or indirect weighing of the analyte in question. This technique usually requires the use of an analytical balance with a sensitivity of 0.1 mg or better.

HALL ELECTROLYTIC CONDUCTIVITY DETECTOR – an element-selective gas chromatography detector primarily intended for trace analysis of organic compounds containing chlorine, nitrogen or sulfur. In operation, this detector pyrolyzes the column effluent gas into soluble electrolytes that are dissolved in a stream of deionized liquid. The observed change in electrical conductivity, proportional to the amount of material present, is measured.

HAZARDOUS WASTE – waste regulated under RCRA that can pose a substantial or potential hazard to human health or the environment when improperly managed. Such wastes possess at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity) or appear on special EPA hazardous waste lists. The term is not interchangeable with hazardous substances or material.

HEADSPACE - Any area in a container not completely filled by the sample in which gases can collect.

HEAVY METALS – metallic elements with high atomic weights, i.e., mercury, chromium, cadmium, arsenic, and lead. They can damage the health of plants and animals at low concentrations and tend to accumulate in the food chain.

HOLDING TIME – the maximum times that samples may be held before analysis and still be considered valid or not compromised. The storage time allowed between sample collection and sample analysis when the designated preservation and storage techniques are employed.

HYDROCARBONS – chemical compounds that consist entirely of carbon and hydrogen.

ICP – Inductively coupled plasma is a type of instrument used for metals analysis. Because the temperature of the plasma is considerable higher (10,000^{o}K) than the temperature of a flame atomic absorption spectrophotometer, it is especially useful for refractory metals. Some instruments are also capable of performing simultaneous multielement analysis.

ICP-MS - Inductively coupled plasma mass spectrometry (ICP-MS) is a type of mass spectrometry highly sensitive and capable of the determination of a range of metals and several non-metals at concentrations below one part in 10^{12} (part per trillion). It is based on coupling together an inductively coupled plasma as a method of producing ions with a mass spectrometer as a method of separating and detecting the ions. In trace elemental analysis, the method has advantages of high speed, precision and sensitivity.

IGNITABLE – capable of burning or causing a fire.

INORGANIC CHEMICALS – chemical substances of mineral origin, unlike organic chemicals whose structure relies on carbon atoms.

INITIAL CALIBRATION VERIFICATION (ICV) - also referred to as the Independent Calibration Verification for this laboratory. A standard solution used to verify the calibration curve derived from a source independent of the instrument calibration standard. The ICV is use to quantify second source standard variance and bias.

INSTRUMENT CALIBRATION STANDARD - a reference material used to standardize an analytical instrument.

INSTRUMENT DETECTION LIMIT (IDL) - a term utilized in the EPA Inorganic Contract Laboratory Program. The IDL is three times the standard deviation obtained for the analysis of a standard solution (each analyte in reagent water) at a concentration of three to five times that of the IDL on three nonconsecutive days with seven consecutive measurements per day. The IDL is the concentration equivalent to a signal, due to the analyte of interest, which is the smallest signal that can be distinguished from background noise by a particular instrument. The IDL should always be below the method detection limit, and is not used for compliance data reporting, but may be used for statistical data analysis and comparing the attributes of different instruments.

INSTRUMENT PERFORMANCE CHECK - The analyses of one of the ICSs to verified initial and continuing calibration (CCV). The IPC is used to quantify the instrumental testing repeatability variance and bias.

INSTRUMENT TUNING - a technique used in gas chromatography/mass spectrometry procedures to verify that the instrument is properly calibrated to produce reliable mass spectral information. See 4-Bromofluorobenzene under “B”.

INTERNAL STANDARDS - compounds added to every standard, blank, matrix spike, matrix spike duplicate, sample (for volatile organics), and sample extract (for semivolatiles) at a known concentration, prior to analysis. Internal standards are used as the basis for quantification of the target compound.

IONIZATION - Utilized in mass spectrometry to fragment analyte molecules into smaller segments. These smaller mass segments are then separated and plotted to form a “mass spectrum” which is used to identify the parent molecule. Electron impact is one example of ionization used in mass spectrometry. In more technical terms. Ionization is the process by which neutral atoms or groups of atoms become electrically charged, either positively or negatively, by the loss or gain of electrons.

ISOMERS - chemical compounds with the same molecular weight and atomic composition by differing molecular structure, e.g., n-pentane and 2-methylbutane.

LABORATORY CONTROL SAMPLE (LCS) - a clean-matrix reference sample spiked with a standard with an established analyte concentration. The LCS is carried through the entire chemical preparation and testing procedures. The LCS is used to quantify the variance and bias of the chemical preparation and instrumental testing stages without matrix interference. Also called a Laboratory fortified blank (LFB).

LABORATORY CONTROL SAMPLE DUPLICATE (LCSD) – a duplicate of the laboratory control sample in a clean matrix that is carried through the entire chemical preparation and testing procedures.

LABORATORY DUPLICATE SAMPLE (LAB DUPLICATE) - a portion of the collected sample that is carried through the chemical preparation and testing. The laboratory duplicate subsample is used to quantify the variance of the chemical preparation and instrumental testing stages with matrix interferences.

LEACHATE - a liquid that results from water collecting contaminants as it trickles through wastes, agricultural pesticides or fertilizers. Leaching may occur in farming areas, feedlots, and landfills, and may result in hazardous substances entering surface water, groundwater or soil.

LDEQ – Louisiana Department of Environmental Quality

LIBRARY SEARCH - a technique in which an unknown mass spectrum of a compound is compared to the mass spectra of compounds contained in a computer library in an effort to identify the compound. Compounds identified in this manner are referred to as tentatively identified compounds (TICs).

LIMIT OF DETECTION (LOD) – an estimate of the minimum amount of a substance that an analytical process can reliable detect. An LOD is analyte and matrix specific and may be laboratory dependent.

LIMIT OF QUANTIATION (LOQ) – the minimum levels, concentrations, or quantities of a target variable (e.g. target analyte) that can be reported with a specified degree of confidence..

LIMS – laboratory information management system. Horizons is the LIMS used by GCAL.

LINEAR CALIBRATION RANGE – the concentration range over which the instrument response is linear.

LOG-IN - the receipt and initial management of an environmental sample. It generally includes identifying who sent the sample; maintaining chain-of-custody; checking report and invoice information; recording analysis requested, including methodology and special instructions; and assigning a discreet in-lab identification, usually a number or bar code.

MASS SPECTRUM - a plot of ion mass/charge ratio versus intensity. A fragmentation pattern results from the particles whose mass distribution is characteristic of the parent molecule. Qualitative information is provided by a mass spectrum.

MATERIAL SAFETY DATA SHEET (MSDS) - a compilation of information required under the OSHA Communication Standard on the identity of hazardous chemicals and their associated health and physical hazards, exposure limits and precautions.

MATRIX - The physical characteristics or state of a sample – e.g., water, soil, sludge.

MATRIX INTERFERENCE - the influence of the sample matrix or sample components upon the ability of qualitatively identifies and quantitatively measures compounds in environmental samples.

MATRIX MODIFIERS - chemicals added to samples for metals analysis, which are used to lessen the effects of chemical interference, viscosity and surface tension.

MATRIX SPIKE (MS) – aliquot of a sample fortified (spiked) with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery of the spike. Matrix spiked samples are used to quantify the variance and bias of the chemical preparation and testing stages with matrix interference.

MATRIX SPIKE DUPLICATE (MSD) - a second aliquot of the same matrix as the matrix spike that is spiked to determine the precision of the method.

METHOD DETECTION LIMIT (MDL) - the minimum concentration of compound that can be measured and reported within 99% confidence that the value is above zero and is determined from analysis of a sample in a given matrix containing the analyte.

MUST – denotes a mandatory requirement.

NARRATIVE - in an analytical report, a descriptive documentation of any problems encountered in processing the samples, along with corrective action taken and problem resolution.

NUTRIENT - any substance assimilated by living things that promote growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.

ORGANIC - generally, any compound that contains carbon bonded to a hydrogen or halogen atom.

OXIDATION - the process in chemistry whereby electrons are removed from a molecule.

PCBs - Polychlorinated biphenyl, a group of toxic persistent chemicals used in transformers and capacitors for insulating purposes and in gas pipeline systems as a lubricant. Sale of PCBs for new uses was banned by law in 1979.

PERCENT RECOVERY - a measure of accuracy that is calculated as the measured value relative to the true value expressed as a percent.

PERFORMANCE AUDIT - a quantitative evaluation of a measurement system that involves the analysis of standard reference samples or materials which are certified as to their chemical composition or physical characteristics.

PROFICIENCY TEST (PT) SAMPLE - a sample of known composition (unknown to the laboratory), provided by an external source, which is used to evaluate lab performance. For certification purposes the PT sample is purchased from an approved provider.

pH - a numerical designation of relative acidity and alkalinity. A pH of 7.0 indicates precise neutrality. Progressively higher values indicate increasing alkalinity and lower values increasing acidity.

POLLUTANT - generally, any substance introduced into the environment that adversely affects the usefulness of a resource.

PRACTICAL QUANTITATION LIMIT (PQL) - the lowest level that can be reliable achieved within specified limits of precision and accuracy routine laboratory operating conditions. The lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value.

PRECISION - a measure of the ability to reproduce analytical results. It is generally determined through the analysis of duplicate samples. The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range in either absolute or relative terms.

PRESERVATIVE - a chemical or reagent added to a sample to prevent or slow decomposition or degradation of a target analyte or a physical process. Physical and chemical preservation may be used in tandem to prevent sample deterioration.

PURGE AND TRAP - a technique used in the analysis of volatile organic where analytes are purged from a sample by means of an inert gas and trapped on a sorbent column. The sorbent is then flashheated and the analytes are transferred onto a gas chromatographic column for separation and identification.

PURGEABLE ORGANIC - an organic compound that is generally less than 20% soluble in water and has a boiling point at or below 200^{o}C. A volatile organic. An organic compound is generally considered to be purgeable if it can be removed from water using the purging process.

QC BASED NESTED APPROACH - a procedure for estimating the uncertainty of measurement using quality control data. The procedure is described in SOP QA-013.

QUALITY ASSURANCE (QA) - all those planned and systematic actions necessary to provide adequate confidence in laboratory results. An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets the defined standards of quality with a stated level of confidence.

QUALITY ASSURANCE PROGRAM PLAN - a written assembly of management policies, objectives, principle and general procedures that outlines how the laboratory intends to generate data of known and accepted quality.

QUALITY CONTROL (QC) – the overall system of technical activities whose purpose to measure and control the quality of a product or service so that it meets the needs of the users.

QUALITY CONTROL CHART - a graph of analytical measurement results for a specific QC standard plotted sequentially with upper and lower control limits (±3SD). A central line that is the best estimate of the average variable plotted, and upper and lower marginal exceedence limits (±4SD) are usually included in the Quality Control Chart. The chart may also include upper and lower warning limits (±2SD).

QUALITY SYSTEM – a structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items) and services. The quality system provides the framework for planning, implement and assessing work performed by the organization and for carrying out required QA and QC.

r^2 – Correlation Coefficient Squared – paramet6er used to evaluate the fit of linear or quadratic regression curve fit of initial calibration data.

RAW DATA – any original information from a measurement activity or study recorded in a laboratory note book, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfilm copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments.

REACTIVITY - the tendency of a chemical to explode under normal management conditions, to react violently when mixed with water, or to generate toxic gases.

REAGENT WATER - water in which an interference is not observed at or above the minimum quantitation limit of interest.

REFERENCE MATERIAL - a traceable standard with an established analyte concentration. Material or substance whose property values are sufficiently homogenous, stable and well established to be used for the calibration of an apparatus, the assessment of a measurement method or for assigning values to materials (ISO Guide 30)

REFERENCE METHOD – a method of known and documented accuracy and precision issued by an organization recognized as competent to do so.

RELATIVE RETENTION TIME – a measure of the shift in retention time of an analyte when referenced to an internal standard.

RELATIVE RESPONSE FACTOR (RRF) - a measure of the relative mass spectral response of an analyte compared to its internal standard. RRFs are determined by analysis of standards and are used in the calculation of concentrations of analytes in samples.

REPLICATE ANALYSES - two or more results representing the same sample parameter. Replicate analyses are used to quantify the analytical measurement repeatability precision.

RPD – Relative Percent Difference, a relative difference between two analyses calculated by dividing the absolute difference of thos two results by the average of therir two values, then multiplying by 100.

RESOLUTION - the degree of separation between peaks eluting from a chromatographic column. Sufficient resolution between peaks is required for proper quantitation of unknown analytes.

RETENTION TIME - a term used in gas and liquid chromatography describing the time elapsed from the sample injection until the specific compound elutes or exits the chromatographic column at the detector. Each compound has a characteristics retention time on a specific column; therefore, this information is used to qualitatively identify the compounds in the sample.

SAMPLE – portion of material collect for chemical analysuis, identified by a unique number assigned by the LIMS.

SHALL – denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled.

SHOULD – denotes a guideline or recommendation whenever noncompliance with the specification is permissible.

SOLID WASTE – non-liquid, non-soluble materials, ranging from municipal garbage to industrial waste, that contain complex, and sometimes hazardous, substances. Solid wastes include sewage sludge, agricultural refuse, demolition wastes, mining residues, and even liquids and gases in containers.

SOLVENT - a substance, usually liquid, capable of dissolving or dispersing one or more other substances.

SPIKE – a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

STANDARD CURVE - a curve that plots concentrations of known analyte standards versus the instrument response to the analyte. Calibration standards are prepared by diluting the stock analyte solution in graduated amounts that cover the expected range of the samples being analyzed. The calibration standards must be prepared by using the same type of acid or solvent at the same concentration as for the samples following sample preparation. This is applicable to organic and inorganic chemical analyses.

STANDARD OPERATING PROCEDURE - a detailed written description of how a laboratory executes a particular procedure or method intended to standardize its performance.

STANDARDIZED REFERENCE MATERIAL (SRM) – a certified reference material produced by the U.S. National Institute of Standards and Technology or other equivalent organization and characterized for absolute content, independent of analytical metho9d.

STANDARD UNCERTAINTY - the analytical measurement uncertainty expressed as a standard deviation. The relative standard deviation represents the relative standard uncertainty.

SURROGATE - an organic compound similar to the analyte of interest in chemical composition, extraction and chromatography, but not normally found in environmental samples. Primarily used in chromatography techniques, the surrogate is spiked into quality control blanks, calibration and check standards, samples (including duplicated and QC reference samples) and spiked samples before analysis. A percent recovery is calculated for each surrogate.

SUSPENDED SOLIDS - small pollutant particles that float on the surface of, or are suspended in, sewage or other liquids. They resist removal by conventional means.

TARGET COMPOUND - specific compounds that are to be quantified in a sample based on a standard list of potential compounds.

TENTATIVELY IDENTIFIED COMPOUNDS (TICs) - compounds detected in samples that are not target compounds, internal standards, system monitoring compounds or surrogates. TICs usually consist of up to 30 peaks that are greater than 10% of the peak areas, or heights, of the nearest internal standard. They are subjected to mass spectral library searches for tentative identification. A client may specify the number of unknown peaks in its samples it wishes the laboratory to tentatively identify.

TOTAL METALS - metallic elements that have been digested prior to analysis.

TYPE A EVALUATION UNCERTAINTY - the method of evaluation of uncertainty by the statistical analysis of a series of test results.

TYPE B EVALUATION OF UNCERTAINTY - the method of evaluation of uncertainty by means other than statistical analysis.

UNCERTAINTY - the parameter associated with the analytical measurement results that characterizes the dispersion of the values that could be reasonable attributed to the quantity measured.

UNCERTAINTY INTERVAL - the range of analyte concentrations that an analytical measurement could represent at a specified level of confidence. The relative standard deviation is used to represent the relative standard uncertainty in the QC-based Nested Approach.

VALIDATION –the process for evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual specifications. It essentially evaluates performance against predetermined specifications.

VOA - volatile organic analysis

VOA BOTTLE - a vial used to contain samples for volatile organic analysis.

VOLATILE COMPOUNDS - compounds amendable to analysis by purge and trap. Synonymous with purgeable compounds.

VOLATILE ORGANIC COMPOUND (VOC) - any organic compound that participates in atmospheric photochemical reactions, except for those designated by the EPA Administrator as having negligible photochemical reactivity.

WET CHEMISTRY - procedures that involve distillations, colorimetric determinations and titrimetric measurements. Examples are chloride, nitrates, sulfates and biochemical oxygen demand.

SUBJECT — SCOPE AND APPLICATION

The sample custodian is responsible for tracking all samples after they are received and logged into the LIMS. The sample custodian verifies samples are stored in the appropriate holding coolers. Logging samples in and out for sample analyses and/or sample disposal is part of daily routine. Preparing samples for outside testing and shipment and keeping records of samples and ice chests is also required. The sample custodian reports directly to the Login supervisor.

DEFINITIONS — See SOP GEN-016

PROCEDURES

1. Sample Receipt

   After samples have been received and logged into the LIMS, samples are stored in the appropriate holding cooler. The samples are assigned to the cooler by the LIMS. Samples requiring volatiles analyses are stored in refrigerator #4 until retrieved by the analysts for storage in the volatiles laboratories. Never store volatile samples in the temporary holding cooler (Refrigerator #2). Samples known to contain corrosive or toxic agents are stored in the hazardous cooler. The samples are labeled "CAUTION" and arranged by work order number. All other samples are stored in the walk-in coolers. The samples are arranged on the shelves of the walk-in coolers according to sample matrix and workorder numbers. The cooler should be kept in order at all times.

2. Sample Release, Return, and Tracking

   Note: Analysts may be required to pull their own samples due to the availability of a sample custodian. However, the following procedure will be followed regardless of who pulls the samples.

   As the analysts bring in their workstations throughout the day, the sample aliquot requested is located, pulled and placed on a cart. Verify the correct bottle is retrieved for the parameter of interest. If a bottle cannot be located, review the chain-of-custody and all parameters listed to verify the bottle was actually received. If all efforts to locate a sample fail, notify the log-in supervisor. When the samples have been pulled and the request is complete, deliver the samples to the analyst or page for pick-up by the analyst. An internal custody is maintained by tracking checkout and check-in of all samples in the LIMS. The LIMS tracking is performed as follows:

   (1) Log onto the LIMS by clicking on the New LIMS icon.

(2) Type your initials and password, hit enter to transfer samples.

(3) The LIMS will give you several options to choose from. Using the mouse, click on the sample field. Scroll down to the custody field. Move the mouse over to the transfer column and single click on it.

(4) The transfer container screen will appear in the destination field, the cursor will be flashing. Type in the department location where the samples will be moved. If you don't know this, move the mouse to the List of Values icon. This will be represented by an upside down triangle with a line under it. Click on the List of Values icon and a list of departments will appear. Scroll down to the appropriate department and double click on the department name. That name will automatically appear in the destination field.

(5) Next is the Release to Field. Type in the analyst name or use the List of Values icon. Click on it and scroll down to the correct analyst and double click.

(6) The Transfer Date is automatic and does not need to be changed. Take the mouse and move the cursor to the Reason Field.

(7) Under the Reason Field type in the reason for the sample to be moved. In the case of someone needing the sample, type in OFA, etc….

(8) After you have typed in the reason move the cursor to the Container Field. Click on the Container Field and now you are ready to scan samples. Once you have finished scanning samples you must put the scanner back in the scanner holder. Take the mouse and move the cursor to the Save icon. The save icon is a yellow disk at the top of the left side of the screen.

(9) Samples must be returned to the appropriate location in the cooler each evening. This will allow empty carts to be available the next morning. Samples may remain on the Oil & Grease cart that is rolled into the cooler for overnight storage. No sample is to be left out overnight.

(10) Log off of the LIMS at the end of each day by moving the cursor to the top right of the screen and click on the close button.

3. Sample Storage

Samples are stored in Walk-In Coolers #1 and #24 for 60 days. After the 60 days samples are scanned to the waste trailer for disposal. This is a daily task performed in order to provide cooler space for incoming samples. Samples to be returned to the client are pulled and delivered by the couriers. Proper chain of custody documentation must accompany these samples. Samples that have been requested to “hold” are held in a designated area in each specific cooler. Disposal of "hold samples" will be performed upon notification from client services.

4. Sample Shipment

Always ship a homogeneous aliquot of sample for outside testing. Unless required by preservative and/or bottle type, do not send the entire sample. Maintain good laboratory and safety practices when splitting samples for shipment. Maintain proper chain-of-custody records. Label samples with work order number and sample number. Do not put the client name on the labels or chain-of-custody. When shipping glass always wrap containers in bubble wrap to prevent breakage. Be sure all ice chests are properly labeled and sealed. All samples to be shipped need to be put on ice. Also custody seals need to be put on ice chests and properly filled out with date, initials, etc.

5. Miscellaneous Duties

Assist log-in, unload ice chests, and label containers. Prepare sample kits, move ice chests to storage area at the end of each day, clean out log-in area and sink daily.

POLLUTION PREVENTION — See QAPP Section 10.2

WASTE MANAGEMENT — See SOP GEN-009

Appendix C

Laboratory Chain of Custody

GULF COAST ANALYTICAL LABORATORIES, INC

Chain of Custody Record

7979 GSRI AVE, BATON ROUGE LA 70820-7402
(225) 769-4900 FAX (225) 767-5717

Lab use only			
Client Name	Client #	Group#	Due Date

Report to:

Client: ______
Address: ______
______
Contact: ______
Phone: ______
Fax: ______

Bill to:

Client: ______
Address: ______
______
Contact: ______
Phone: ______
Fax: ______

Analytical Requests & Methods

P.O. Number

Project Name/Number

Sampled By:

Matrix	Date	Time (2400)	Comp	Grab	Sample Description	Pre-serva-tives	No. Con-tainers												**Remarks:**	Lab ID

Turn Around Time: ____ 24 - 48 hrs ____ 3 days ____ 1 week ____ standard other ______

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

Note:

By submitting these samples, you agree to the terms and conditions contained in our most recent schedule of service:

Matrix: W = water, S=Soil, SD=Solid, L=Liquid, SL=Sludge, O=Oil, CT=Charcoal Tube, OVM=Organic Vapor Monitor, XT=XAD Tube, A=Air Bag, SUM=Summa Canister